Louisiana Coastal Area (LCA), Louisiana

Ecosystem Restoration Study

July 2004

Draft

Appendix E – Plan Formulation

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LOUISIANA COASTAL AREA (LCA), LOUISIANA

ECOSYSTEM RESTORATION STUDY

APPENDIX E

PLAN FORMULATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 ALTERNATIVE FORMULATION

1.1 Summary of Plan Formulation Phases and Development Methods

Each phase of the plan formulation process provided distinct results that were used to initiate the following phase. **Figure E-1** depicts the plan formulation phases and the development methods used to complete each phase and progress to the next one.

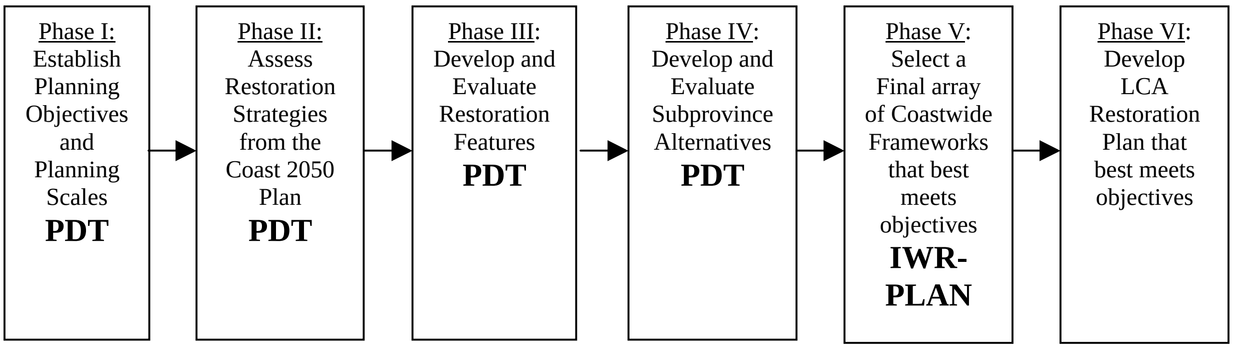

Figure E-1. Plan Formulation Phases and Development Methods.

The following information summarizes the development methods used for each plan formulation phase.

1.1.1 Establish Planning Objectives and Planning Scales (Phase I)

- Based on professional judgment and extensive experience in coastal Louisiana restoration, the Project Delivery Team (PDT) developed the Planning Objectives and the Planning Scales.
- The PDT established two "provinces," the Deltaic Plain and Chenier Plain. These were further divided into four functional ecological "subprovinces."

1.1.2 Assess Restoration Strategies from the Coast 2050 Plan (Phase II)

- The PDT, in conjunction with the Vertical Team (VT) and Framework Development Team (FDT), reviewed the Coast 2050 Plan and the Louisiana Coastal Area (LCA) Section 905(b) reconnaissance report. These efforts identified the following core strategies for coastal restoration.
  - To create and sustain wetlands through input and accumulation of sediment.
  - To maintain estuarine and wetland salinity gradients for habitat diversity.
  - To maintain ecosystem linkages for the exchange of organisms and system energy.

1.1.3 Develop and Evaluate Restoration Projects and Features (Phase III)

- The PDT developed restoration features for each of the subprovinces using professional judgment and extensive experience in coastal Louisiana restoration with the core strategies for coastal restoration as a guide.
- Sub-groups of the PDT developed restoration features to fit the strategic requirements of each subprovince. This phase identified a range of practical and accepted restoration features along with their characteristics. The PDT succeeded in developing and quantifying restoration features for coastwide restoration.
- Each feature was developed independently with preliminary costs and land-building or land-loss-modifying potential being estimated based on best available information and professional judgement.
- Potential restoration footprints for each feature were delineated and designers began to develop scaleable designs and cost estimates. In addition, for any features introducing additional water resources, the designers provided relative levels of freshwater introduction and land building for each level.
- Preliminary estimates of the ecological output of each feature (in acres created) were made. In addition to any available land-building estimates, the teams considered current land-loss rates within each footprint and estimated the degree that this might be reduced by the considered feature, allowing an estimate of acres protected.
- The team made initial assessments of the positive, negative, or neutral fit of the features to the major goals and objectives established for the study. This positive, negative, or neutral assessment was also made for each feature against a broad range of significant resources. These assessments were used to identify and screen any features that would not support the environmental goals of the study.

1.1.4 Develop and Evaluate Alternatives – Select a Final Array of Coastwide Frameworks (Phase IV)

- The assembly of frameworks using study criteria, best available information, and professional judgment was adopted as an acceptable method to combine features into subprovince alternatives.
- Utilizing ecological criteria previously established, these teams combined the restoration features into alternative frameworks capable of achieving the various identified restoration scales. Applying the ecological criteria and the projected output for each restoration feature, the alternative development teams developed several significantly different frameworks for each desired subprovince output level.
- The PDT used existing hydrodynamic and ecological models, as well as agency and academic expertise, on a select number of alternative frameworks in each subprovince to produce a base of information. Based on the combined effects of the individual features from the desktop-model output for each alternative, the PDT produced benefit assessments. These assessments were also completed for any discreet, combinable features. The effects of the alternative frameworks were documented using multiple ecological output metrics.
- With a "toolbox" of restoration features developed, and a range of quantitative scales for the study identified, the teams assembled a variety of alternative frameworks for meeting these scales at the subprovince level. Features were combined to form

alternative frameworks. As they worked through framework development, it became apparent that all of the prescribed scale levels could not be achieved for every subprovince.

1.1.5 Evaluation of Alternative Frameworks

The evaluation methodology for the alternative frameworks was developed to capture their systemic relationships and outputs on a subprovince-wide scale, and involved a multi-tiered modeling and data processing structure.

The PDT evaluated alternatives within the subprovinces with extensive academic and interagency support using three consecutive analytic processes: simulation models, desktop models, and restoration benefit calculation.

- Previously tested hydrodynamic simulation models existed within all the study subprovinces.
- Desktop models based on linked spreadsheets were developed for the subprovinces and projected land building, habitat switching, habitat use, and water quality.
- The benefit computation methodology utilized the output provided by the desktop models to estimate the ecological output of each framework.

1.1.6 Select Coastwide Framework Which Best Meets Objectives (Phase V)

- A number of restoration features were developed for various portions of the coastal area. These features were combined to form alternative frameworks. Many of the proposed features cannot be combined, while others do not function without other features in place. Also, many features produce more or less benefit--or have higher or lower costs--when combined. These interactions were accounted for when calculating the benefits and costs of each framework.
- In the cost-effectiveness analysis, the frameworks were assessed according to their ability to produce output for a given cost level. Frameworks that maximized output-per-dollar spent were retained, while all other frameworks were eliminated. The result was a list of frameworks that achieve each output level at the lowest cost, or an efficient frontier.
- The cost-effectiveness assessment was followed by incremental cost analysis. Incremental cost is the additional cost for each change in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated framework selection in the absence of a deterministic rule (such as maximizing net benefits, as is done in National Economic Development (NED) analysis).
- Potential economic impacts of the frameworks were roughly estimated and taken into consideration in project selection as follows: after Cost Effectiveness and Incremental Cost Analysis (CE/ICA), potential economic effects of frameworks in the final array were estimated on a gross basis to inform the PDT of the magnitude of these effects.
- The Institute for Water Resources (IWR)-Plan computer program (Version 3.3, USACE--Institute for Water Resources) was used to automate the CE/ICA. Costs

and benefits were amortized over the 50-year period of analysis at the current Federal discount rate of 5.875 percent. Costs were estimated at the October 2003 price level.

- The CE/ICA used implementation costs (construction and real estate acquisition) measured against ecological benefit output units. The comparison of the coastwide alternatives was based on the sum of subprovince alternative framework ecological benefits versus cost, as provided by the IWR-Plan analysis. The CE/ICA analysis was used to filter the coastwide alternatives down to an array of the most cost-effective frameworks.
- For the development of the final array, cost-effectiveness criteria were also applied. The combined weighted ecological outputs provided by the models and benefit protocols were documented for each coastwide alternative. The combined weighted outputs and costs for each alternative were also displayed and ordered by cost. The primary factors of interest were ecological benefit versus cost, and an assessment of economic effects.

1.1.7 Select Near-Term Alternative (Phase VI)

- Having identified the most efficient, effective, and complete combinations of frameworks in Phase V, the final array of alternative coastwide frameworks was used as the starting point. Development of the restoration features combined into the system frameworks was predominantly based on addressing areas of critical wetland loss, opportunities for the reestablishment of deltaic processes, and the protection and restoration of geomorphic features.
- The system frameworks in the final array identified 79 potential restoration features across the coast from which alternative restoration plans could be developed. The framework formulation process also afforded the USACE and the local sponsor with an iterative process whereby any restoration feature that might be considered critical in nature, by any criteria, could be included and assessed through multiple levels of input.
- The resulting array of alternative coastwide frameworks is therefore viewed to encompass all measures that could possibly be considered as addressing a critical ecological need.
- The LCA VT (Vertical Team) concluded that the intended components would include: features to address near-term critical restoration opportunities that could begin construction within the next 5 to 10 years, demonstration projects to resolve scientific or technical uncertainties, large-scale studies of long-range feature concepts to more fully capture restoration opportunities, and programmatic authority to ensure optimal environmental use of ongoing navigation maintenance material.
- Criteria were then developed to identify which restoration features contained in the final array of coastwide frameworks would be placed into the various component categories.

- The coastal restoration strategies in Louisiana suggest that while these restoration alternatives have significant environmental benefits, they each exhibit weaknesses in addressing the complete range of study planning objectives. One recommended alternative would exhibit long-term sustainability, as the geomorphic structures serve to protect and buffer the diversion feature influence areas from erosive coastal wave action and storm surge. Additionally, river diversion features would be more sustainable because they would be continuously connected to the river resource and nourished by its sediment and nutrients.

2.0 ESTABLISH PLANNING OBJECTIVES AND EVALUATION CRITERIA (PHASE I)

A Goals and Endpoints Group was developed within the PDT. This group reviewed information from all previous study efforts to identify ecological goals and possible endpoints for potential long-range, large-scale ecosystem restoration strategies. The underlying objectives for the pursuit of these restoration features were the continued productivity and protection of the environment, economy, and the culture of southern Louisiana and their contributions to the national economy. Criteria for identifying appropriate strategies included: resulting overall habitat suitability in the coastal zone; wetland-building potential; ability to assimilate nitrogen and reduce overall contributions to the Gulf of Mexico; and the effect on coastal economic activity. Phase I established two “provinces,” the Deltaic Plain and Chenier Plain, within the Louisiana coastal zone for planning purposes. These were further divided into four functional ecological subprovinces.

The LCA has a variety of potential future landscapes, ranging from a landscape where no additional actions are taken to address land loss, to a landscape where extensive large-scale efforts are made to revitalize the coast. Deciding which future landscape to plan for is a complex decision, involving difficult and numerous environmental, social, and economic constraints (or trade-offs). In order to evaluate the improvements to the ecosystem in the context of these various constraints and decide upon a course of action in an ecosystem restoration plan, a variety of options must be reviewed. Thus, a key first step in developing a plan for restoring coastal Louisiana is to define different possible future landscapes (or planning scales) and assess potential alternatives.

Using the planning objectives and the “Comprehensive Study Guiding Principles for Plan Formulation,” the PDT defined planning scales to facilitate the development of alternatives. For the purposes of this report, the term “scale” does not refer to a specific state of the landscape. Rather, it reflects the degree to which environmental processes would be restored or reestablished, and the resulting ecosystem and landscape changes that would be expected over the next 50 years. Restoring impaired environmental processes in coastal Louisiana would affect the net rate at which coastal wetlands are lost or gained. Therefore, the planning scales for LCA are expressed in terms of the net rate of landscape loss or gain in coastal Louisiana.

The reference point for the planning scales is the estimate of future net land loss rates under the No Action scenario. For both the Deltaic Plain and Chenier Plain provinces, there are estimates of the annual net loss of wetlands over the next 50 years assuming that no additional restoration efforts (beyond the Coastal Wetland Planning, Protection and Restoration Act (CWPPRA) and other existing programs) are implemented.

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Based on professional judgment and extensive experience in coastal Louisiana restoration, the PDT determined that the highest, most ambitious scale would be an annual net increase in wetland acreage equal to 50 percent of the projected rate of loss. (This uppermost scale is referred to as "*Increase.*") Obviously, the lowest possible scale would be no further action above and beyond the existing projects and programs. The PDT determined that no net loss of coastal wetlands would be an appropriate intermediate scale, consistent with the long-held National wetlands policy of no net loss. (This scale is referred to as "*Maintain.*") Finally, reducing the projected loss rate by 50 percent was judged to be another appropriate intermediate scale, as it is sufficiently different from the other scales and would offer an option that, while not aggressively addressing the problem, could nevertheless provide substantial benefits over no action. (This scale is referred to as "*Reduce.*")

The use of acreage of land as a basis for the planning scales for this stage in the process in no way suggests that the other important objectives did not receive full consideration throughout the planning process. Acreage was used at this stage in the process not only because it was the simplest and most tangible measure around which alternatives could be formed, but also because it is an appropriate surrogate for the many important functions and values provided by Louisiana's coastal wetlands. In this sense, acreage was seen as an umbrella for the other objectives. Once alternatives were identified, the effects of alternatives relative to the other objectives were quantified during later stages of the planning process via hydrodynamic, ecological, and desktop modeling evaluations and benefit assessments.

Based on projections from the U.S. Geological Survey (USGS) (reference appendix B), the No Action annual land loss rate is estimated to be -10 mi^2/yr [-25.9 km^2/yr] (the minus sign designating a net loss of land). The ecological planning scales are based on reduction or reversal of the annual net land-loss rate. The scales are defined as follows:

- *<u>No Action (Future Without Project)</u>:* The annual land-loss rate if no additional features are taken to restore coastal Louisiana = -10mi^2/yr [-25.9 km^2/yr]
- *<u>Reduce:</u>* The annual net land-loss rate reduced by 50 percent = -5mi^2/yr [-12.9 km^2/yr]
- *<u>Maintain</u>:* There is no net annual loss of land (land gain would equal land loss) = 0 mi^2/yr [0 km^2/yr]
- *<u>Increase:</u>* The rate of annual net land-gain is 50 percent of the No Action annual net land loss rate = +5 mi^2/yr [+ 12.9 km^2/yr]

Table E-1.
Planning Scales by Subprovince.

	Land Change (ac/yr)			
	FWO [1]	**Reduce [2]**	**Maintain [2]**	**Increase [2]**
Subprovince 1	-806 ac/yr	+403 ac/yr	+806 ac/yr	+1,209 ac/yr
Subprovince 2	-2,291 ac/yr	+1,146 ac/yr	+2,291 ac/yr	+3,437 ac/yr
Subprovince 3	-2,842 ac/yr	+1,421 ac/yr	+2,842 ac/yr	+4,263 ac/yr
Subprovince 4	-461 ac/yr	--	+461 ac/yr	+692 ac/yr
Total	-6,400 ac/yr	+2,970 ac/yr	+6,400 ac/yr	+9,601 ac/yr
Total (mi^2/yr)	-10.0	+4.6	+10.0	+15.0

Notes:
1. *Numbers for FWO (future without project) are an estimated loss rate, and are subject to change.*
2: *Numbers for "reduce," "maintain," and "increase" scales are the gross amount of acres restored and/or protected. For net acreage change in any subprovince, the FWO number should be subtracted from the gross acreage protected.*

2.1 Province and Subprovince Planning Areas

Two major, but distinct, geological processes formed the Louisiana coast. One such process was the formation of sequential deltaic lobes of the Mississippi River, resulting in the Deltaic Plain in the eastern and central part of Louisiana's coast. The second major process was the formation of a series of beach ridges, or cheniers, that form the Chenier Plain in the western part of the state. For planning purposes, these two geomorphic provinces have been subdivided into four subprovinces, based on logical dividing lines between hydrologic basins.

Under the CWPPRA and Coast 2050 processes, Louisiana's coastal area is divided into four "regions" and nine hydrologic "basins." The hydrologic basins are further divided into mapping units that reflect similar problems and potential solutions. The LCA process has modified the CWPPRA divisions into "provinces" and "subprovinces" using different geologic and hydrologic criteria. The scales discussed above will initially be used at the subprovince level, with the exception of Subprovince 4. Therefore, due to relatively lower projected loss rates, the "reduce" scale has been dropped in recognition of the apparent attainability of the higher scales.

3.0 ASSESS RESTORATION STRATEGIES FROM THE COAST 2050 PLAN (PHASE II)

The PDT, in conjunction with the VT, and with suggestions from the individual members of the FDT, consisting of representatives from Federal and state agencies, academia, and the public, reviewed the Coast 2050 Plan and the LCA Section 905(b) reconnaissance report (for which the Coast 2050 Plan was the basis). These reports identified perceived problems in both

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- To create and sustain wetlands through input and accumulation of sediment
- To maintain estuarine and wetland salinity gradients for habitat diversity
- To maintain ecosystem linkages for the exchange of organisms and system energy

Additionally, six public scoping meetings were held throughout coastal Louisiana in April 2002. At these meetings, input from the public was solicited regarding the scope of issues (problems, needs, and opportunities) as well as strategies for restoration. These comments were considered when developing the strategies.

In Subprovince 1, the core strategies identified for restoration included: upper-basin diversions, lower-basin diversions, and control of salinities basin wide. The closure or constriction of the existing Mississippi River-Gulf Outlet (MRGO) navigation project was identified as a potentially significant component of the salinity control strategy. The marshes in the vicinity of Violet, LA were similarly identified as a critical target area for the lower basin diversion strategy.

Upper-basin introduction of freshwater, sediments, and nutrients is a strategy geared toward the maintenance of the large expanse of cypress-tupelo swamp located in the area. These swamps require the input of fine sediments and nutrients to maintain optimal water depths for regeneration and to stimulate bio-productivity. In addition, diversions can alleviate drought conditions, which can allow elevated salinities to encroach into upper portions of the basin. These incursions accelerate the transition of already stressed vegetative classes.

The lower-basin diversion strategy represents a broader need in the lower portion of the basin. The introduction of consistently elevated salinities over an extended period has resulted in wide-spread vegetative stress and subsequent habitat transition. In a significant portion of the area this transition has been to open water. A primary need in this area is the introduction of river sediments to stem subsidence coupled with freshwater to create an environment capable of sustaining more flood-tolerant vegetation over the near term. Freshwater introduction will have the added benefit of stimulating productivity with the accompanying waterborne nutrients.

The last strategy embodies the basic theme in this subprovince that the spatial and temporal control of salinity is key to maintaining healthy vegetative and estuarine communities. This strategy is geared toward the reduction of elevated salinities entering the marshes adjacent to the MRGO as well as those bordering lakes Pontchartrain and Maurepas.

In Subprovince 2 the core restoration strategies identified were: sustaining barrier islands, headlands, and shorelines; managing the available sediments of the Mississippi River; Mississippi River water and sediment introduction via the Third Delta; and preserving the land bridges within the Barataria Basin.

The barrier-shorelines in Subprovince 2 are some of the fastest eroding in the country. These landforms provide protection to adjacent marshes, reduce hurricane surge, define the vital bay habitat, support trees and shrubs that are essential to migratory songbirds, provide protection to inland oil and gas facilities, etc. Their continued stability will ensure the availability of these functions and habitats. Additionally, their presence increases the effectiveness of features addressing the introduction of resources from the Mississippi River and protects the function of the estuary as a whole.

The coastal wetlands are receiving less sediment than during the periods when the Mississippi River built them through overflow of its banks. Management of the river basin and the land within it for social and economic development has effectively cut off the coastal wetlands from a principal supply of sediment, freshwater, and nutrients. Exploration for, and the subsequent extraction of, natural resources in the coastal wetlands have further exacerbated the situation by increasing the effective export of sediments from the system. The reintroduction and management of these riverine resources to the wetlands would restore a key component for system stability.

The land bridge across the central portion of the Barataria Basin estuary is rapidly deteriorating. It is viewed as a vital strategic component in the maintenance of the estuarine salinity gradient throughout the basin. The continued stability of this geomorphic feature would ensure the stability of upper-basin wetland habitats, as well as aiding in the management of resources in that portion of the basin.

The core strategies for restoration in Subprovince 3 involved some geographic specificity because of its multi-basin makeup, but included: restoration of the Terrebonne/Timbalier barrier islands; rebuilding land in eastern Terrebonne Basin; modification of the Old River Control Complex operation scheme to increase sediment input to the Atchafalaya River; Mississippi River water and sediment introduction via the Third Delta; and management of Atchafalaya River freshwater, sediment, and nutrients.

The Terrebonne/Timbalier barrier island chain has suffered extensive degradation over the last 150 years, including the loss of extensive areas of coastal wetlands leeward of these features. The loss of these islands threatens the function of the estuarine bay system and the form, as well as the stability, of the remaining wetlands that fringe the interior of these bays.

The eastern portion of the Terrebonne Basin has experienced some of the highest rates of marsh loss on the entire coast over the last 50 years. The area is also hydrologically isolated from major sources of riverine input and continues to incur high rates of loss. The stabilization of wetland loss in this area would be key to achieving a coastwide balance in system function.

The balance of riverine resources between the Mississippi River and the Atchafalaya and Red rivers, and their delivery to the coastal zone, is maintained through the operation of the Old River Control Complex. As discussed previously, the distribution of flow between the Lower Mississippi and Atchafalaya systems is maintained at 70 percent of the latitude flow versus 30 percent, respectively. For optimum function in Subprovince 3 an increase in the sediments directed into the Atchafalaya River system would provide additional wetland building potential in an area currently in a growth phase.

The last core strategy in Subprovince 3 builds upon the previous strategy. The Atchafalaya River, in combination with the Wax Lake Outlet Channel (WLOC), is currently in the building phase of delta development. This river system also provides freshwater and sediment to large portions of the Terrebonne estuary's wetlands. The proactive management of those available riverine resources would greatly increase the current productivity of the estuarine system.

In the Chenier Plain, which is encompassed by Subprovince 4, there are no excess riverine resources available to promote land building and to control salinities in the estuarine system. As a result, the core strategy for this subprovince is the control of estuarine salinities through the management of existing hydrology and geomorphologic features. Because the coastal landscape is continually subsiding relative to the level of the Gulf of Mexico, the physical exclusion of gulf salinities and management of natural rainfall and runoff inputs to the system will provide the best opportunities to maintain system stability.

4.0 DEVELOP AND EVALUATE RESTORATION PROJECTS AND FEATURES (PHASE III)

Using the core strategies for coastal restoration as a guide, the PDT undertook the development of restoration features for each of the subprovinces. The features that were developed also needed to be able to be combined to achieve the established planning scales. Four public meetings were held throughout coastal Louisiana in February 2003. At these meetings, input from the public was solicited regarding the development of restoration features to address the restoration strategies. The PDT assembled into sub-groups to develop restoration features to fit the strategic requirements of each subprovince. This phase of plan formulation identified a range of practical and accepted restoration features along with their characteristics. The PDT succeeded in developing and quantifying an initial suite of discreet possible solutions for coastwide restoration.

In this phase, each feature was developed independently with preliminary costs and land building, or land loss modifying, potential being estimated based on experience and insight gained through the execution of the CWPPRA program, along with the best available information and professional judgment. The ten years of effort in project development and design under the CWPPRA program, along with design work completed under other Federal and State programs, provided an extensive base of design information to build on. Detailed documentation of the design assumptions, feature level of detail, and development of the cost estimates is available at the Engineering Division of the New Orleans District office of the U.S. Army Corps of Engineers (USACE). The result of this phase was a "tool box" of restorations features for each subprovince. This phase of plan formulation also provided insight into the types of tools and metrics that would be required in the plan evaluation process.

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During this phase, 166 potential restoration features were developed. The intent of this effort was to provide an initial identification of the most effective frameworks for meeting the overarching study objectives, in concert with key strategies in each subprovince. The features are specific projects, such as freshwater reintroduction (diversion), sediment diversion, outfall management, hydrologic restoration, interior shoreline protection, barrier island and barrier headland restoration, and marsh creation and restoration. A brief description of the various types of features is provided below:

- *Freshwater Reintroduction (Diversion) Projects:* Freshwater reintroduction (diversion) projects restore deteriorated wetland areas with the nourishment of freshwater, sediment, and nutrients. Freshwater helps to relieve areas that have suffered from the effects of saltwater intrusion, while sediment and nutrients promote the growth of new marsh in areas that are subsiding.
- *Sediment Diversion Projects:* Sediment diversions allow nutrient- and sediment-rich freshwater to flow into surrounding wetlands. This is similar to freshwater diversion, but maximizes sediment input.
- *Dedicated Dredging and Beneficial Use, Marsh Creation and Restoration Projects:* Dedicated dredging marsh restoration projects utilize sediment that is dredged for maintenance of navigation channels and access canals, or material that may be dredged specifically for marsh restoration. The sediment is placed in a deteriorated wetland or open water area at a specific elevation so that desired marsh plants will colonize and grow to form new marsh.
- *Salinity Control:* Salinity control projects provide for the construction of new structures or the operation of existing structures for the purpose of controlling saltwater intrusion.
- *Hydrologic Restoration Projects:* Hydrologic restoration projects address problems associated with artificially altered hydrology by reverting deteriorated drainage patterns toward more natural drainage patterns.
    - Structure Modification Projects
    - Hydrologic Modification Projects
- *Land Acquisition:* In instances where land is deemed valuable to the successful structure and function of restoration projects, it may be in the best interest of the public and the environment to acquire this land via easements or fee purchase.
- *Barrier Island, Barrier Headland, and Interior Shoreline Protection and Restoration Projects:* Barrier island restoration projects are designed to protect and restore Louisiana's barrier islands that protect interior areas and provide important stopover habitat for many migrant avian species. Shoreline protection projects are designed to decrease or halt shoreline erosion. Some actions are applied directly to the eroding shoreline, while others are placed in the adjacent open water to decrease a wave's energy before it hits the shoreline. This could promote the buildup of sediment and includes planting of vegetation, as necessary.

In each subprovince, the composition of the techniques represented in the features was guided, but not limited, by the critical restoration strategies identified for that area. The range of the magnitude of output was geared to be commensurate with the identified ecological scales within each subprovince. **Table E-2** provides the makeup of restoration features by subprovince.

Table E-2.
Types of Restoration Features by Subprovince.

Feature Type	Subprovince 1	Subprovince 2	Subprovince 3	Subprovince 4
Freshwater Reintroduction (Diversion)	21	30	1	
Sediment Diversion	21	18	1	
Dedicated Dredging and Beneficial Use / Marsh Creation and Restoration	12	4	1	1
Salinity Control	1		2	16
Structure Modification (Hydrologic Restoration)	4	1		
Hydrologic Modification (Hydrologic Restoration)	1		12	4
Land Acquisition	1			
Barrier Island, Barrier Headland, and Interior Shoreline Protection and Restoration	1	1	10	2

The initial efforts in developing the restoration features involved identifying potential restoration footprints within a subprovince and developing scaleable designs to achieve various levels of success. As an example, a footprint for a large sediment-reintroduction feature would be delineated by the team and the total potential area for restoration within it identified using a Geographic Information System (GIS). With a point of introduction and estimated total-material-volume-required provided, designers would then produce max-mean-min designs and sediment reintroduction requirements. These levels were typically 70 percent and 35 percent reduction in open water area or a minimum mean introduction of flow. The use of three sizes wherever possible in developing features allowed flexibility in scaling the features when assembling alternative frameworks. For smaller reintroduction features focused on system management, three mean flows would be prescribed for an area based on the experience and judgment of the team.

This technique worked well for features that involved the reintroduction or addition of water or sediment to a system. For strategies where management of *in situ* conditions was required or in areas where the input of additional resources was not an option, the development of features focused on management. The development of these features was typically controlled by existing geomorphology and the level of natural system inputs. The combination of features developed for the management of Atchafalaya River water moving through the Terrebonne Basin of Subprovince 3 is an example of this. These features are dependent on the existing channel and ridge network, which produces both the current hydrology and the potential for modifying it. Another example would be the combination of features to manage salinity in the Chenier Plain. Due to the morphology of the Chenier Plain, this strategic objective can be accomplished with a few major features at the perimeter of the basin or a number of smaller features in the interior of the basin.

Once the team had delineated the potential restoration footprints for each feature, designers began developing scaleable designs and cost estimates. In addition, for any features introducing additional resources, the designers provided relative levels of freshwater introduction and land building for each level. The team developing the features was then able to make preliminary estimates of the ecological output (in acres created) that each feature would produce. In addition to any available land-building estimates, the teams considered current land-loss rates within each footprint and estimated the degree that this rate might be reduced by the considered feature. This allowed the team to estimate acres protected by each feature as well. The team also made initial assessments of the positive, negative, or neutral fit of the features to the major goals and objectives established for the study. This positive, negative, or neutral assessment was also made for each feature against a broad range of significant resources. These assessments were used to identify and screen any features that would not support the environmental goals of the study.

5.0 DEVELOP AND EVALUATE ALTERNATIVES – SELECT A FINAL ARRAY OF COASTWIDE FRAMEWORKS (PHASE IV)

Due to the number of possible restoration features and scales, as well as the number of possible combinations, the effort of developing all possible framework outputs was unmanageable within even a standard study timeframe. The assembly of alternative frameworks using study criteria, best available information, and professional judgment was adopted as an acceptable method to establish model scenarios. The evaluation of these frameworks developed across the range of identified output scales that would then provide an evaluation framework from which relative effectiveness and completeness of frameworks could be gauged.

Utilizing the ecological criteria established in the initial phase of the study, these teams combined the restoration features into alternative frameworks capable of achieving the various identified restoration scales. The alternative development teams utilized the broader goals, principles, and guidelines to formulate criteria for creating similar alternative groups of features across the ranges of restoration scales in each subprovince. Applying the ecological criteria and the output projection established for each restoration feature, each alternative development team developed several significantly different frameworks for each desired subprovince output level. An initial framework for formulation goal was an array of ten alternative frameworks (including No Action) for each subprovince.

The PDT selectively used existing hydrodynamic and ecological models, as well as agency and academic expertise, on a limited number of alternative frameworks in each subprovince to produce a base of information. "Desktop" hydrologic and ecological models were developed based on the numeric modeling output. The application of these desktop models to the remaining alternative frameworks was undertaken by the PDT members. From the desktop model output for each alternative, based on the combined effects of the individual

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With a "toolbox" of restoration features developed and a range of quantitative scales for the study identified, the next plan formulation step was to assemble a variety of alternative frameworks for meeting these scales at the subprovince level. Features were combined to form frameworks. With a large number of features to work with, the possible combinations were numerous. As the sub-groups worked through the development of the frameworks, it became apparent that for some subprovinces the available restoration features would not allow the achievement of all the prescribed scale levels.

Subprovince Frameworks
Subprovince 1 = 10 Alternatives
Subprovince 2 = 10 Alternatives
Subprovince 3 = 5 Alternatives
Subprovince 4 = 7 Alternatives

Nevertheless, the PDT's goal was to examine different approaches for meeting a specific scale. With that goal, the frameworks were intended to represent different hypotheses for ways to meet the various scales. Moreover, the alternatives needed to be distinct enough to provide for real choice among them. In planning terminology, the alternatives were developed to be "significantly different." So as not to make the analysis of alternative frameworks overly complex, the number developed for each subprovince to address a planning scale was limited to three, unless such a limit excluded a reasonable framework or restoration feature that would not otherwise be reviewed. These 32 alternatives were presented in four public meetings held in May and June 2003. Comments and recommendations received were considered to finalize the alternatives.

The Summary of Specific Alternative Frameworks (by Subprovince) section of the main report describes each of these frameworks. In addition, the specific frameworks provide detailed descriptions of each and its features.

5.1 Subprovinces 1 and 2

In the initial effort to develop alternatives for subprovinces 1 and 2, it became evident that there could be three different approaches (or frameworks) for meeting any given scale. Because the fundamental restoration approach for the Deltaic Plain is freshwater and sediment reintroduction, these three conceptual frameworks relate specifically to the design, operation, and ecosystem effects of reintroduction features. The following is a description of each conceptual framework, along with the rationale for its use:

Minimize Salinity Changes: Freshwater reintroductions affect salinity gradients and, therefore, can result in significant ecological changes. Many of the social and economic benefits currently provided by the ecosystem are based on the distribution of marsh types and salinity conditions that have prevailed for several decades. While the long-term goal of freshwater reintroductions is to ensure a healthy, productive, and sustainable coast, such features can change fisheries and wetland habitat types so that local harvesters and communities can no longer realize these benefits. The question then becomes whether it is possible to meet each planning scale in a way that minimizes such potential changes, while still providing for a sustainable coastal ecosystem. To answer this question, one alternative for each scale was developed in a way that seeks to minimize salinity changes. Alternatives consistent with this conceptual framework rely less on freshwater re-introduction and more on marsh creation using external sediment sources (including off-shore and riverine sources). Although the primary features for building marsh platforms are mechanical, limited freshwater reintroductions are included to help ensure the long-term sustainability of existing and restored wetlands. Additionally, the inclusion of freshwater reintroductions would provide an element of self-design, albeit to a relatively limited extent. This framework was applied throughout both subprovinces, in particular in the upper portion of Subprovince 1, where salinity increases are already recognized as a threat to the ecosystem and reducing salinity was a goal of any alternative.

Continuous Reintroduction (w/Stage Variation): In coastal Louisiana, the existing freshwater re-introduction projects (such as Davis Pond and Caernarvon) are for the most part operated with a continuous (i.e., year-round) flow, with discharge volume varying according to river stages and ceasing when river stages are too low. It is likely that the same approach to year-round reintroduction of water would provide effects at the larger scale that are not apparent with the existing diversions. Moreover, given that the natural deltaic process has been massively disrupted, the existing projects still fall far short of meeting the freshwater, nutrient, and sediment needs of subprovinces 1 and 2. By developing alternatives around a “continuous re-introduction” framework, the LCA process would be able to assess the potential benefits and costs of using more and larger reintroductions that operate year-round. This framework also allows for analysis of the water quality/hypoxia benefits that could be derived from maximum use of freshwater reintroduction.

Mimic Historic Hydrology: Alternatives under this conceptual framework are based on the assumption that historic hydrologic regimes (apart from river switching) in the Deltaic Plain Province were characterized by numerous, smaller seasonal freshwater inflows (from over-bank flow, small distributaries, and minor crevasses) combined with relatively short-term episodes of large freshwater inflows due to major flood-induced crevasses. Alternatives designed under this framework include numerous, smaller re-introductions combined with large reintroduction projects to be operated in periodic “pulsing” events. Consistent with this framework, the “increase” scale in Subprovince 2 includes the “Third Delta”, as well as relocation of navigation on the Mississippi River (to allow for more dynamic deltaic processes at the mouth of the river). Where appropriate, alternatives under this framework also include sediment enrichment of reintroduction waters to mimic the historically higher sediment loads in the Mississippi River. In addition to testing whether mimicking historic hydrology would meet the various scales, this conceptual framework may also provide a way to help restore deltaic processes, while minimizing any potential impacts associated with the year-round reintroduction features discussed above.

Using these three frameworks would not result in alternatives that are totally different from each other. Indeed, certain features may be included under all or many alternatives for a particular subprovince (e.g., barrier islands in Subprovince 2). Such common elements are often included because they either represent a structural component needed to make an alternative complete or are viewed as being valuable under a variety of scenarios. Moreover, where appropriate and consistent with the given conceptual framework, features were assembled in a way that sought to spread potential benefits throughout each subprovince. For example, though much of the "reduce" scale in Subprovince 1 could potentially be addressed by features taken in the upper portion of the subprovince, the use of such features was limited for the sake of developing alternatives with greater balance and geographic completeness. Finally, in using these frameworks to develop alternatives, care has been taken to ensure that reintroduction projects did not divert too much river flow, which could have consequences for navigation and possibly other existing uses of the river. The same consideration applies to some Subprovince 3 alternatives, as well to the combination of reintroduction alternatives from all three subprovinces.

5.2 Subprovince 3

Environmental and geologic conditions vary considerably across Subprovince 3. The western portion of the subprovince experiences lower subsidence rates and has the benefit of large volumes of freshwater, sediments, and nutrients flowing down the Atchafalaya River, resulting in ongoing deltaic growth. The eastern portion of the subprovince has a far higher land loss rate and has limited opportunities for freshwater reintroduction. The conceptual frameworks for Subprovince 3 reflect both the opportunities and the constraints facing wetland restoration in this area. Specifically, the frameworks represent different approaches to maximizing the use of potential and existing freshwater sources, while also restoring important geomorphic features.

Maximum Atchafalaya Flow: The ongoing deltaic land growth at the mouth of the Atchafalaya River and Wax Lake Outlet is both a rare source of new wetland acres in coastal Louisiana and a clear example of the benefits that can be derived from restoring deltaic processes. Alternatives developed under this framework seek to increase to the maximum extent possible the ongoing land growth, while also redirecting Atchafalaya River waters to help nourish wetlands in the Terrebonne Basin. In addition to improving natural deltaic processes, alternatives under this framework would involve mechanical features (i.e., sediment delivery) to further expedite and increase land growth. Increased flows down the existing Bayou Lafourche would also be assessed as a means for reducing loss rates in eastern Terrebonne Basin. Finally, as with the other conceptual frameworks for Subprovince 3, alternatives under this framework will include features designed to rehabilitate or maintain important geomorphic features, including barrier islands, land bridges, and gulf shorelines.

Land Building by Delta Development: Given the challenge of reintroducing significant amounts of freshwater, sediments, and nutrients to the eastern portion of Subprovince 3, it would take a massive effort to reestablish deltaic land growth in this area. The only feature potentially capable of doing so is the "Third Delta," an ambitious proposal to create a massive new distributary channel from the Mississippi River to both the Barataria and Terrebonne basins. To assess the effects of such a feature, alternatives developed under this conceptual framework would center on implementation of the Third Delta. While relying primarily on this new distributary channel, these alternatives would also include moderate, complementary efforts to increase Atchafalaya Delta development, move Atchafalaya waters to the east, and restore critical geomorphic features.

Mississippi and Atchafalaya Flows: Alternatives developed under this conceptual framework represent a hybrid of the two former frameworks. Specifically, these alternatives would employ both the Third Delta, and more extensive efforts to increase Atchafalaya Delta development and move Atchafalaya River waters to the east, while also maximizing efforts to rehabilitate and maintain critical geomorphic features.

5.3 Subprovince 4

Salinity control has been identified as the "keystone strategy" for Subprovince 4. The increased water demands of Texas have also threatened the freshwater inflows that reduce salinity advancement up the Sabine River. With the proposed enlargement of the subprovince's navigation channels, the potential for increases in salinity and loss of vegetative marshes rises. Specifically, the deepening of Calcasieu and Sabine passes for navigation has been demonstrated to be the primary cause of increased salinity levels, which in turn have resulted in significant impacts to the area's wetland resources. Accordingly, the main conceptual frameworks for alternatives in Subprovince 4 represent different approaches to addressing the fundamental problem of increased salinities. The following is a description of the three conceptual frameworks:

Large-scale Salinity Control: The foundation of alternatives developed under this framework is large-scale salinity control structures (i.e., locks or gates) at Calcasieu Pass and Sabine Pass. Such structures would be designed and operated to ameliorate the salinity increases caused by the deepening of these passes for navigation purposes. While not exactly restoring the historic dimensions of the passes, these structures would have the effect of restricting saltwater inflows in the same general location that such restrictions existed in the past with minimum impacts to navigation. Theoretically, implementation of such an alternative could allow for modification or removal of existing upstream salinity control measures, thereby supporting the restoration of a more natural and less-managed hydrologic regime throughout the subprovince.

Perimeter Salinity Control: Alternatives developed under this conceptual framework are intended to reduce salinity impacts, while also avoiding any potential effects that locks or gates on the Calcasieu and Sabine passes may have on navigation. Specifically, this group of alternatives would include small-scale salinity control features around the perimeters of Calcasieu and Sabine lakes, thereby reducing saltwater intrusion to adjacent wetlands and waterways. Such structures would be state-of-the-art, designed to minimize disruption of organism and material linkages. However, unlike the large-scale salinity control alternatives, a perimeter approach would likely not limit any increased salinity of the current ecological character and social and economic uses of the Calcasieu and Sabine passes and lakes. This alternative would incorporate and build upon existing perimeter control structures.

Freshwater Introduction Salinity Control: Alternatives developed under this conceptual framework rely less on structural salinity-blocking features and more on hydrologic modifications to bring additional freshwater into the northern portion of the estuaries as the primary means for reducing salinities. Specifically, these alternatives would use culverts and other existing structures as conduits for increased flow of freshwater, which in turn would reduce salinity levels within the Calcasieu and Sabine estuaries. Freshwater introduction across Highway 82 in the Mermentau Basin would aide in reducing salinities in the Chenier Subbasin. Such alternatives would be intended to aid in the restoration of more natural hydrologic regimes, while having the added benefit of minimizing potential adverse socioeconomic impacts associated with the structural approaches considered in the first two frameworks--particularly with respect to the restriction of organism and material linkages and impacts to navigation.

As with the other LCA subprovinces, there are specific features that are common to many of the Subprovince 4 alternatives. For example, as recommended by some members of the National Technical Review Committee (NTRC), beneficial use of material dredged for navigation purposes is included in many alternatives. In addition, excessive impoundment of water has been identified as a major stressor of the wetlands. A number of alternatives do, therefore, include features to help reduce excessive water levels, in addition to allowing fresh water to flow southward to higher salinity areas, including the use of structures to improve freshwater flow across LA Highway 82. Finally, as with barrier islands to the east, gulf shoreline stabilization has been included throughout the alternatives in recognition of the critical function served by the Chenier Plain gulf barrier headland.

5.4 Summary of Specific Frameworks (By Subprovince)

A summary of the features included in each framework by subprovince is provided in this section (see **tables E-3** to **E-6**).

Subprovince 1--Mississippi East (Breton/Pontchartrain)

This section will address alternatives for Subprovince 1 with the following scales: (1) reduce, (2) maintain, and (3) increase the amount of wetlands in the subprovince area. There are a total of ten alternatives for this subprovince: three "reduce" (R); three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table E-3**).

Subprovince 2 -Mississippi West (Barataria)

This section will address alternatives for Subprovince 2 with the following scales: (1) reduce, (2) maintain and (3) increase the amount of wetlands in the Subprovince area. There are a total of ten alternatives for this subprovince: three "reduce" (R); three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table E-4**).

Subprovince 3 - Terrebonne, Atchafalaya and Teche / Vermilion

This section will address alternatives for Subprovince 3 with the following scales: (1) reduce and (2) maintain. There are a total of ten alternatives for this subprovince: three "reduce" (R); one "maintain" (M); and the supplemental framework (N) (**table E-5**).

Subprovince 4 - Chenier Plain

This section will address alternatives for Subprovince 4 with the following scales: (1) maintain and (2) increase. There are a total of ten alternatives for this subprovince: three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table E-6**).

Table E-3. Specific Alternatives, Subprovince 1.

Subprovince 1	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
15,000 cfs diversion at American / California Bay				x			x	x		
110,000 cfs diversion (div.) at American / California Bay with sediment enrichment			x		x					x
250,000 cfs div. at American / California Bay with sediment enrichment						x			x	
12,000 cfs div. at Bayou Lamoque		x	x		x	x		x	x	x
5,000 cfs div. at Bonnet Carre Spillway	x	x		x						
10,000 cfs div. at Bonnet Carre Spillway						x	x	x	x	
200,000 cfs div. at Caernarvon w/ sediment enrichment								x		
1,000 cfs div. at Convent / Blind River			x			x			x	
5,000 cfs div. at Convent / Blind River		x			x		x			x
10,000 cfs div. at Convent / Blind River								x		
15,000 cfs div. at Fort St. Philip			x	x			x			
26,000 cfs div. at Fort St. Philip w/ sediment enrichment						x				
52,000 cfs div. at Fort St. Philip w/ sediment enrichment									x	
1,000 cfs div. at Hope Canal	x	x	x	x	x	x			x	x
1,000 cfs div at Reserve Relief Canal									x	
6,000 cfs dive. at White's Ditch							x			
10,000 cfs div. at White's Ditch		x	x		x	x			x	x
Sediment delivery by pipeline at American/ California Bay				x			x		x	
Sediment delivery via pipeline at Central Wetlands	x			x			x			
Sediment delivery via pipeline at Fort St. Philip				x			x			
Sediment delivery via pipeline at Golden Triangle							x			
Sediment delivery via pipeline at La Branche	x			x			x			x
Sediment delivery via pipeline at Quarantine Bay	x						x			
Authorized opportunistic use of the Bonnet Carre Spillway.										x
Increase Amite River influence by gapping dredged material banks on diversion canals.										x
Marsh nourishment on the New Orleans East land bridge.										x
Mississippi River Delta Management Study.										x
Mississippi River Gulf Outlet Environmental Features and Salinity Control Study.					x		x			x
Reauthorization of the Caernarvon freshwater diversion. (optimize for marsh creation).										x
Rehabilitate Violet Siphon and post authorization for the diversion. of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands.										x

Note: Gross rates of restored/ protected wetlands: R = Reduce, 406 ac/yr; M = Maintain, 806 ac/yr ; E = Increase, -1,209 ac/yr; Scales: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology. Description of the features can be found in Section 2.6 of the main report.

Table E-4. Specific Alternatives, Subprovince 2.

Subprovince 2	**R1**	**R2**	**R3**	**M1**	**M2**	**M3**	**E1**	**E2**	**E3**	**N1**
5,000 cfs diversion (div.) at Bastion Bay/Buras			x							
130,000 cfs div. at Bastion Bay/Buras		x								
120,000 cfs div. near Bayou Lafourche									x	
60,000 cfs div. at Boothville w/ sediment enrichment.										x
1,000 cfs div. at Donaldsonville		x	x		x	X				x
5,000 cfs div. at Donaldsonville w/ sediment enrichment								x		
1,000 cfs div. at Edgard		x	x		x	X				x
5,000 cfs div. at Edgard w/ sediment enrichment	x							x		
5,000 cfs div. at Empire			x							
90,000 cfs div. at Empire								x		
5,000 cfs div. at Fort Jackson			x							
60,000 cfs div. at Fort Jackson	x			x						
60,000 cfs div. at Fort Jackson w/ sediment enrichment						X	x	x		
90,000 cfs div. at Fort Jackson w/ sediment enrichment									x	
150,000 cfs div. at Fort Jackson w/ sediment enrichment					x					
1,000 cfs div. at Lac des Allemands		x			x	X				x
5,000 cfs div. at Lac des Allemands w/ sediment enrichment				x			x	x	x	
5,000 cfs div. at Myrtle Grove	x		x	x			x			x
15,000 cfs div. at Myrtle Grove		x								
38,000 cfs div. at Myrtle Grove w/ sediment enrichment					x					
75,000 cfs div. at Myrtle Grove w/ sediment enrichment						X				
150,000 cfs div. at Myrtle Grove w/ sediment enrichment								x		
5,000 cfs div at Oakville			x							
1,000 cfs div. at Pikes Peak		x	x		x	X				x
5,000 cfs div. at Pikes Peak w/ sediment enrichment								x		
5,000 cfs div. at Port Sulphur			x							
Barrier Island restoration at Barataria Shoreline	x	x	x	x	x	X	x	x	x	x
Marsh creation at Wetland Creation and Restoration feasibility study sites	x			x			x		x	x
Mississippi River Delta Management Study.										x
Reauthorization of Davis Pond.										x
Relocation of Deep Draft Navigation Channel							x		x	
Sediment delivery via pipeline at Bastion Bay				x			x			
Sediment delivery via pipeline at Empire			x	x			x			
Sediment delivery via pipeline at Head of Passes				x			x			
Sediment delivery via pipeline at Myrtle Grove	x			x			x			x
Third Delta Re-evaluation										x

Note: Gross rates of restored/ protected wetlands: R = Reduce, 406 ac/yr; M = Maintain, 806 ac/yr ; E = Increase, -1,209 ac/yr; Scales: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology. Description of the features can be found in Section 2.6 of the main report.

Table E-5. Specific Alternatives, Subprovince 3.

Subprovince 3	R1	R2	R3	M1						N1
Backfill pipeline canals			x	x						
Bayou Lafourche 1,000 cfs pump	x	x		x						x
Convey Atchafalaya River water to Terrebonne marshes	x		x	x						x
Freshwater introduction south of Lake De Cade	x	x		x						
Freshwater introduction via Blue Hammock Bayou	x	x		x						x
Increase sediment transport down Wax Lake Outlet	x	x		x						x
Maintain land bridge between Bayous Dularge and Grand Caillou	x		x	x						x
Maintain land bridge between Caillou Lake and Gulf of Mexico.			x	x						x
Maintain northern shore of East Cote Blanche Bay at Pt. Marone			x	x						x
Maintain Timbalier land bridge			x	x						
Multipurpose operation of the Houma Navigation Canal (HNC) Lock.	x	x	x	x						x
Penchant Basin Plan	x	x	x	x						x
Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island	x	x	x	x						
Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west	x	x	x	x						
Rebuild Point Chevreuil Reef			x	x						x
Rehabilitate northern shorelines of Terrebonne/Timbalier Bays			x	x						
Relocate the Atchafalaya navigation channel	x	x		x						x
Restore Terrebonne barrier islands.			x	x						x
Stabilize banks of Southwest Pass			x	x						
Stabilize gulf shoreline of Point Au Fer Island			x	x						x
Study the modification of the Old River Control Structure (ORCS) Operational Scheme to Benefit Coastal Wetlands	x	x		x						x
Third Delta (120,000 cfs diversion)		x		x						

Note: Gross rates of restored/ protected wetlands: R = Reduce, 406 ac/yr; M = Maintain, 806 ac/yr ; E = Increase, -1,209 ac/yr; Scales: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology. Description of the features can be found in Section 2.6 of the main report.

Table E-6. Specific Alternatives, Subprovince 4.

Subprovince 4				M1	M2	M3	E1	E2	E3	N1
Black Bayou Bypass culverts.										x
Calcasieu Pass Lock				x			x			
Calcasieu Ship Channel Beneficial Use				x	x	x	x	x	x	x
Chenier Plain Freshwater Management and Allocation Reassessment.										x
Dedicated Dredging for Marsh Restoration					x	x		x	x	
East Sabine Lake Hydrologic Restoration					x			x		x
Freshwater introduction at Highway 82				x	x	x	x	x	x	x
Freshwater introduction at Little Pecan Bayou				x	x	x	x	x	x	x
Freshwater introduction at Pecan Island				x	x	x	x	x	x	x
Freshwater introduction at Rollover Bayou				x	x	x	x	x	x	x
Freshwater introduction at South Grand Chenier				x	x	x	x	x	x	x
Freshwater introduction via Calcasieu Lock and Black Bayou culverts						x			x	
Gulf Shoreline Stabilization					x		x	x	x	x
Modify existing Cameron-Creole Watershed Control Structures					x			x		x
New Lock at the GIWW					x			x		
Sabine Pass Lock				x			x			
Salinity control at Alkali Ditch					x			x		x
Salinity control at Black Bayou					x			x		x
Salinity control at Black Lake Bayou					x			x		x
Salinity control at Highway 82 Causeway					x	x		x	x	x
Salinity control at Long Point Bayou.					x			x		x
Salinity control at Oyster Bayou					x			x		x

Note: Gross rates of restored/ protected wetlands: R = Reduce, 406 ac/yr; M = Maintain, 806 ac/yr ; E = Increase, -1,209 ac/yr; Scales: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology. Description of the features can be found in Section 2.6 of the main report.

5.5 Evaluation of Subprovince Frameworks

The evaluation methodology for the frameworks was developed to capture their systemic relationships and outputs/benefits on a subprovince-wide scale. The evaluation involved a multi-tiered modeling and data processing structure combining hydrodynamic simulation through numerical modeling, ecological change projection through linked database computation, and database processing of modeling and change projections to produce a final estimate of framework outputs.

Alternatives within the subprovinces were evaluated using three consecutive analytic processes: simulation models, desktop models, and restoration benefit calculation (**figure E-2**). Simulation models are used to determine hydrodynamic endpoints. The next step, desktop modeling, is used to determine attributes associated with alternatives such as habitat use, water quality, land building, and habitat switching. Finally, restoration benefits are evaluated for each alternative or combination of alternatives.

5.5.1 Model Analyses

The relationship between the simulation and desktop modeling is developed through the output from the hydrodynamics model (**figure E-3**). This output is delivered to the land building, habitat switching, and water quality modules. The hydrodynamic output quantities include sediment, water level, salinity, and rate of flow. The next relationship is between land building and habitat switching modules and habitat use module. Land/water ratios output from the land building modules are used in the habitat use module. Also, from the habitat switching module, habitat types are used in the habitat use module.

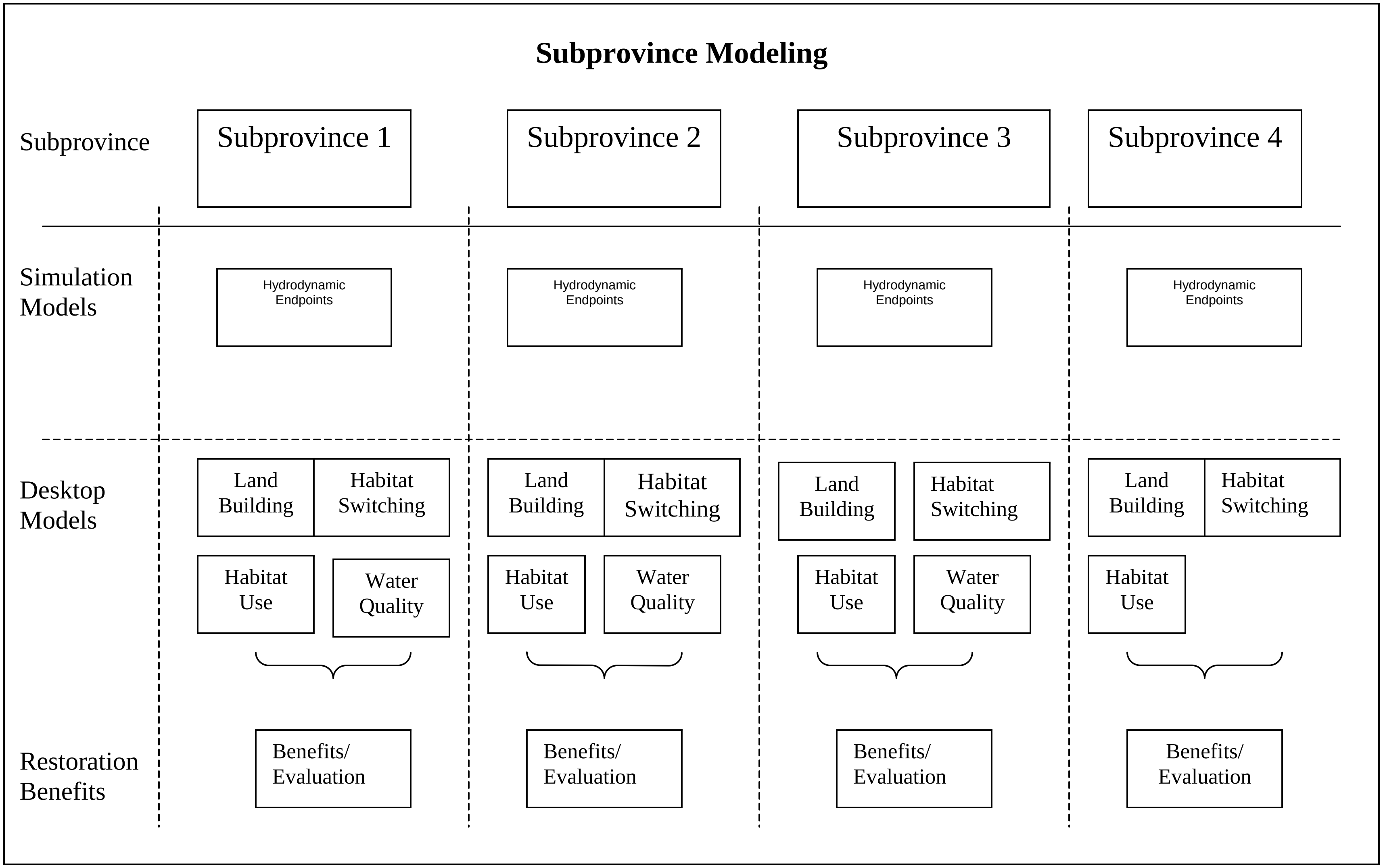

Figure E-2. Modeling Processes Used in the Various Subprovinces.

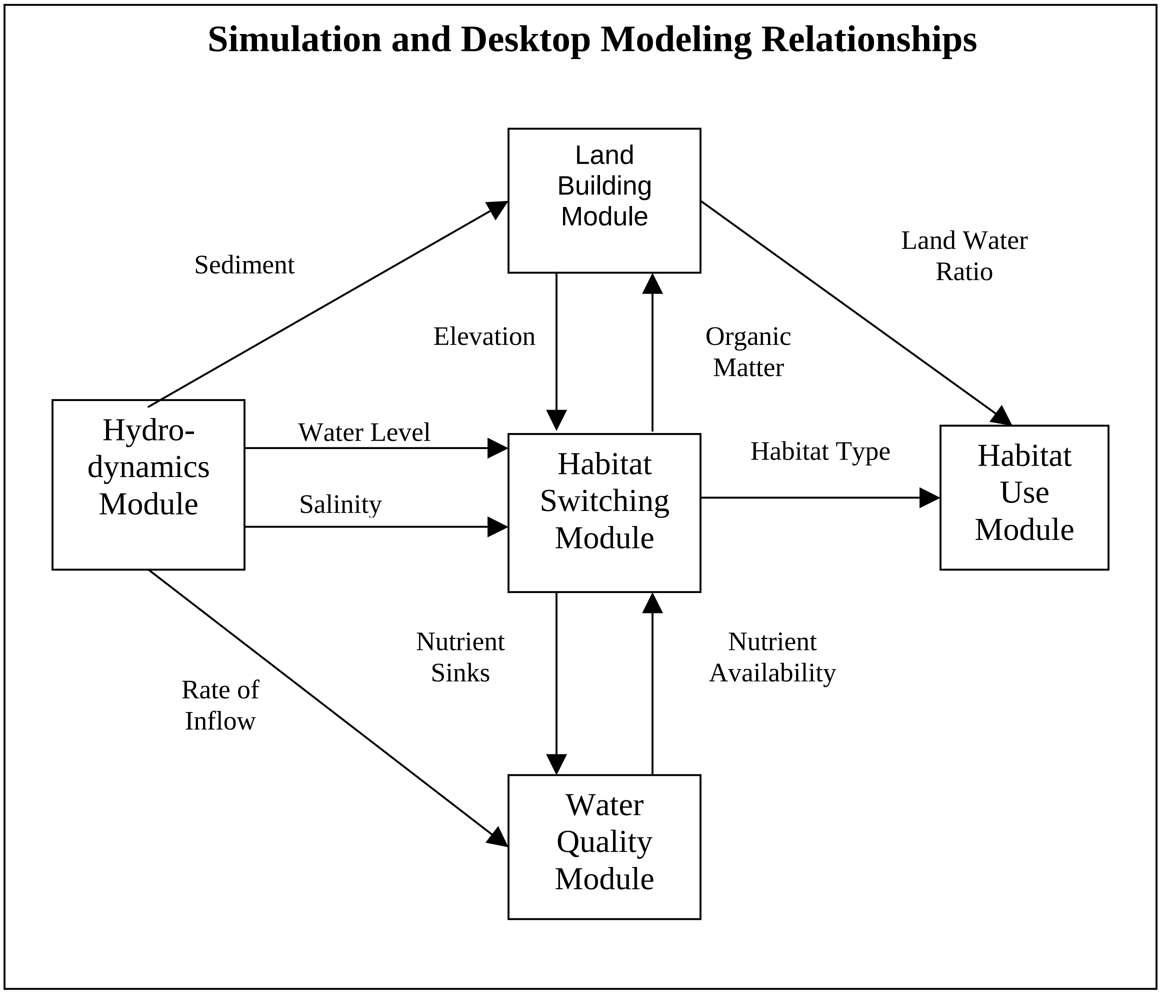

Figure E-3. The Relationship Among the Various Modules of the Desktop Model.

The PDT relied on existing and previously tested hydraulic models within the study area to address hydrology and salinity distribution. Hydrodynamic models existed within all the study subprovinces. The desktop models were based on linked spreadsheets and were developed for all the subprovinces to project land building, habitat switching, habitat use, and water quality. The benefit computation methodology was developed to utilize the output provided by the desktop models to estimate the ecological output of each framework. The PDT also called upon a combination of academic and interagency support for the modeling effort. As the developers of the existing models, they were best able to execute the required simulations.

To establish inputs for the hydraulic models, discharge rating curves for each proposed diversion feature were developed. The criteria for these designs were a stated nominal discharge (at the 50 percent exceedence stage) of the Mississippi River at that location. A digital record of daily stages for each Mississippi River gage for the period of analysis (1977-2002) was used to determine the 50 percent exceedence stages along the river throughout the study area. The number of daily values for the period of record was totaled and the minimum and maximum stage values identified. The total range of the record for each gage was divided into equal stage increments, and the total number of values equal to or greater than each increment was determined. The percentage of the values that is equal to or greater than a particular increment value can then be computed. Therefore, 100 percent of the values in the record will equal or exceed the minimum stage value at a given gage. The maximum stage value for a given gage would be exceeded zero percent of the time. The term 50 percent "duration" stage was used to signify the stage value that is exceeded 50 percent of the time.

The stages that were equaled or exceeded 50 percent of the time on a yearly basis were used in sizing the diversion structures and developing discharge curves at various locations along the river. Therefore, the description for a 5,000-cubic foot per second (cfs) diversion refers to the "nominal" capacity of the diversion. The diversions are capable of delivering substantially more flow than the nominal capacity since the river stages at a particular location will be greater than the yearly 50 percent duration stage at least one-half of the time. Conversely, half of the time the diversion will pass less than 5,000 cfs, and for some locations, when river stages are very low, the diversion will not pass any flow from the river into the receiving area.

While at any given river location the correlation between the 50 percent duration stage and the average discharge of the Mississippi River is not exact for the purposes of diversion sizing and determining flow budget, these two values are assumed to be equivalent. Therefore, the sum of the design flows for the diversions in any alternative framework reflects the total volume of flow that would be diverted from the river at its annual average discharge.

The basic protocol for the evaluation effort was for the use of the existing hydrodynamic models to simulate base conditions and up to three framework configurations for one year. The model simulations focused primarily on the effects of changing freshwater input to a system where appropriate. In Subprovince 4 (Chenier Plain), the frameworks focused heavily on management of tidal exchange and therefore the model simulations did as well. The model simulations provided a range of effects for a representative number of frameworks in each subprovince. Members of the PDT were then able to extrapolate the salinity effects for the remaining frameworks in each subprovince as necessary. In a similar manner, where other numeric models were able to simulate specific effects, output for simulated frameworks was used to verify the desktop projections for additional frameworks.

The basis for the desktop models was a series of linked spreadsheets containing algorithms or equations for various components of ecological change and quality. The cells of the spreadsheets were correlated to 1-km-square grid cells laid across the coastal landscape, thus simulating spatial expression. For each ecological component the database contains a series of cells representing months of the year and therefore producing a 1-year simulation. Successive linked spreadsheets produce the effect of projecting the ecological components over a corresponding number of years, or time steps of multiple years, if desired.

The salinity output, either from the numeric simulations or through extrapolation, provided the basic input for the desktop models. This information was combined with basic volumetric data regarding river sediment load, mechanically introduced sediment load, and flow rates for individual framework features. Parameters of location and time for the mechanical placement of dredged sediment to create land were also provided as input to the desktop models.

Desktop model outputs consisted of 15 output categories that include: habitat suitability of 12 fauna, nitrogen removal, primary productivity, and wetlands acreage. The 12 fauna (Habitat Suitability Index (HSI)) outputs are valued between 0 and 1. These fauna are categorized by salinity preference as follows: high salinity (juvenile brown shrimp, juvenile white shrimp, juvenile spotted seatrout), medium salinity (oysters, juvenile Atlantic croaker, juvenile gulf menhaden, muskrat), and low salinity (largemouth bass, mink, otter, dabbling duck, alligator).

5.5.2 <u>Benefit Assessment Protocols</u>

Benefit protocols were developed to synthesize the ecosystem dynamics information being generated by the desktop models in the assessment of LCA alternatives (**table E-7**). The information covers an array of ecosystem attributes and functions, and the benefits protocols provide a means of comparing complex patterns, both in space and time, of ecosystem change. The protocols were formulated and developed by a multi-disciplinary team of agency experts and university scientists with extensive experience of both the Louisiana coastal ecosystem and of the use of ecosystem benefits features in restoration planning and assessment.

The benefit protocols each contribute to the decision making process in different ways. Benefit protocol #2 was used as input to IWR-Plan as part of the incremental cost-effectiveness analysis. The other benefits protocols provide additional information on specific aspects of an ecosystem as well as measure the effectiveness of alternative frameworks relative to the two ecosystem objectives identified for the LCA Plan. Those objectives are: increase land-water ratios, increase connectivity and material exchanges to improve *productivity* and sustain diverse *fish and wildlife habitats*, and reduce nutrient delivery to the shelf by routing Mississippi River waters through estuarine basins. These data were used to inform the decision makers as they developed an implementation strategy using the IWR-Plan results.

Table E-7 summarizes the role of each of the six benefit protocols developed to support LCA decision-making. A detailed description of the rationale for each protocol and the specifics of the algorithms to be used are provided in a separate document.

Table E-7.
Summary Description of LCA Benefit Protocols

Protocol #	**Aspect of Ecosystem Change**	**Essential inputs**
B1	Productivity and Habitat use – Habitat Quality	Primary productivity of land and water Use of habitat by 12 coastal species
B2	Quantity of land, Quality of habitat and Nitrogen removal	Acres of land Primary productivity of land and water Use of habitat by 12 coastal species Removal of N from Mississippi River water.
B3	Quantity of land	Acres of land
B4	Nitrogen removal	Removal of N from Mississippi River water
B5	Value of fish and wildlife habitat	Use of habitat by 12 coastal species
B6	Selected stakeholder interest issues	Various combinations of the assessment output (see detailed description below)

All benefit values represent the net difference between the future with the alternative (FWA) and No Action alternative, or the future without the alternative (FWO). This calculation is made for each protocol with benefit values for all alternatives, including No Action. The ordering of the protocols reflects the team development process and does not imply an order in which they will be applied or any priority ranking.

Some of the inputs in **table E-7** were available from the desktop models at a resolution of 1km^2 across the coast. Thus 1 km^2 is the smallest scale at which any of the protocols can be applied. Others are, by definition, values that describe the effect of an alternative at the subprovince scale (e.g., acres of land). The vast array of information provided by the alternatives assessment process allows the individual benefits protocols to use input at many spatial scales across the coast. In all cases the protocols seek to reflect the effect of the alternative on the entire subprovince.

While the models used to generate the output were applied at various time steps, the desktop approach allows benefits to be calculated in annual increments. The protocols that produce information in “unit” form (e.g., habitat units) could be accumulated at ten-year intervals to provide information on benefits over 50 years, or benefits over shorter intervals both as a net value and as average annual benefits.

Benefit Protocol B1--Quality of Habitat--was developed to reflect the relative progress made by alternatives in reaching Ecosystem Objective #1. It combines two components:

- Primary Productivity
- Habitat Use

Values for each component are derived, as described below, for each 1 km^2 cell and combined to produce a HSI that reflects quality of habitat (HSIQL). The HSIQLs of all cells within a subprovince are totaled to account for the area of the subprovince and produce habitat quality units (HQUs).

Benefits Protocol B2—Composite Benefits--is the protocol used to generate values for input into the IWR-Plan. It is one number generated from three individual benefit protocols, which indicates the achievements of the alternative in meeting ecosystem objectives 1 and 2 and also indicates the success in creating or preserving land. The three components combined to produce this value were:

- Quality of Habitat
- Quantity of Land
- Nitrogen removal

Values for each component are derived for each 1 km^2 cell and combined to produce an overall suitability index (OSI). The OSIs of all cells within a subprovince are totaled to account for the area of the subprovince and produce benefits units (BUs).

Benefits Protocol B3--Quantity of Land--measures the achievement of the alternative in creating and preserving land within the subprovince. As all benefits are expressed relative to No Action, B3 consists of the amount of land (including wetlands, barrier islands, ridges, etc., but not fastlands, which are excluded by the subprovince boundary) produced by the alternative after 50 years. The units are in acres.

Benefits Protocol B4--Nitrogen Removal--gauged the alternatives in meeting ecosystem objective #2 by assessing the amount of nitrogen removed by the alternative in tons per year, as provided by the water quality desktop module. To put this in the context of overall frameworks for nutrient reduction in the Mississippi River, this value is presented relative to the Action Plan goal developed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force that was presented to the U.S. Congress in January 2001. The action plan calls for a 30 percent reduction in nitrogen loading. The mean annual load of total nitrogen delivered to the Gulf of Mexico is 1,763,698 tons [1.6 million metric tons] (CENR 2000). A 30 percent reduction of this would be 529,109 tons [480,000 metric tons] annually.

Benefits Protocol B5--Value of Fish and Wildlife--reflects the fish and wildlife habitat value for each marsh habitat type (i.e., fresh/intermediate, brackish, and saline) within a subprovince. The habitat use desktop models will provide an HSI for each species (listed in **table E-8**) for each 1 km^2 cell.

Table E-8.
Species Included in Benefit and Variable Designations

V1 White shrimp	V7 Largemouth bass
V2 Brown shrimp	V8 American alligator
V3 Oyster	V9 Muskrat
V4 Gulf menhaden	V10 Mink
V5 Spotted seatrout	V11 Otter
V6 Atlantic croaker	V12 Dabbling ducks

The HSI values were averaged across all cells, for each habitat type, for each species, being used to determine habitat quality for that zone. Each species was weighted based on its relative importance in determining habitat quality for a specific habitat type. For instance, in the fresh/intermediate model, brown shrimp, oyster, and spotted seatrout are not used (or weighed with a zero) because they are not important in determining habitat quality in that zone.

Benefits Protocol B6--Selected Stakeholder Interests--includes features that reflect aspects of ecosystem change which are of specific interest to stakeholders or resource agencies. The features included here will likely change as the decision-making process proceeds and issues arise for which information regarding alternative performance is required.

6.0 SELECT A FINAL ARRAY OF COASTWIDE FRAMEWORKS THAT BEST MEETS PLANNING OBJECTIVES (TO BE ACCOMPLISHED AFTER PUBLIC COORDINATION) (PHASE V)

The PDT created the coastwide frameworks that were composed from each province and evaluated them using the Institute for Water Resources (IWR)-Plan computer program (Version 3.3, USACE). The automated program grouped the 32 subprovince frameworks into thousands of different combinations. The program then performed a cost effectiveness and incremental cost analysis (CE/ICA) using outputs/benefits and the estimated costs, that had been previously developed in the initial plan formulation phases, summed for the combined groups restoration features.

The benefits of the project alternatives are defined in ecological habitat units. Consequently, the analytical approach selected produced a comparison of costs expressed in dollars to benefits stated in habitat units. A CE/ICA was performed using this data.

In the cost-effectiveness analysis, the frameworks were assessed according to their ability to produce total ecological outputs for a given cost level. Frameworks that maximize output per dollar spent were retained, while all other frameworks were eliminated. The result is a listing of frameworks that achieve each output level at the lowest cost, or an efficient frontier. The cost-

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The development of multiple ecological metrics allowed the PDT greater flexibility in the evaluation of the ecological trade-offs and efficiencies between alternative combinations. The PDT also employed a tiered incremental analysis of the alternative frameworks using the IWR-Plan. The tiered analysis addressed the optimization of alternative frameworks first in each subprovince of the coastal zone. Then, utilizing the optimal frameworks for each subprovince, the optimal framework combinations for the entire Louisiana coastal zone were developed. This methodology allowed both incremental and spatial optimization to occur in framework selection across the coast.

The cost and benefit input, though based on features that for the purpose of this study effort are surrogates for the ultimate projects that will be detailed in future documents, is critical to the task of identifying the most effective and appropriate system restoration framework to work from. With this analysis, the PDT was able to identify a final array of coastwide system frameworks that were most cost effective (i.e. those frameworks that held potential to produce the greatest amount of benefits in comparison to its cost). Frameworks that could maximize output per dollar spent were retained, while all other frameworks were eliminated.

6.1 Cost Effectiveness and Incremental Cost Analysis

The benefits of this project were defined in habitat units. Consequently, a CE/ICA was performed since this allowed the comparison of benefits measured in habitat units and costs measured in dollars.

A number of restoration features were developed for various portions of the coastal area. These features were combined to form frameworks. Many of the proposed features cannot be combined, while others do not function effectively alone (without other features in place). Also, many features produce more or less benefit--or have higher or lower costs--when combined. These interactions were accounted for when calculating the benefits and costs of each framework.

In the cost-effectiveness analysis, the frameworks were assessed according to their ability to produce output for a given cost level. Frameworks that maximized output per dollar spent were retained, while all other frameworks were eliminated. The result was a listing of frameworks that achieved each output level at the lowest cost, or an efficient frontier.

The cost-effectiveness assessment was followed by incremental cost analysis. Incremental cost is the additional cost of each change in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated framework selection in the absence of a deterministic rule (such as maximizing net benefits, as is done in National Economic Development analysis).

Potential economic impacts of the frameworks were grossly estimated and taken into consideration in project selection as follows. After the CE/ICA was completed, economic impacts of frameworks in the final array were estimated on a gross basis to inform the PDT of the magnitude of these effects. The effects were then used as tiebreakers to select a recommended framework from the list of cost-effective frameworks.

The costs and benefits of the frameworks were amortized over a 50-year period of analysis at the current Federal discount rate of 5.875 percent. Costs were estimated at the October 2003 price level.

6.2 Combinability of (Alternatives) Frameworks

An initial function performed by the IWR-Plan software was the generation of all possible framework configurations. Utilizing the costs and benefit outputs developed for the various subprovince frameworks and criteria established for their combinability, the program assembled all the possible coastwide framework combinations. The primary determining factor for the combinability of various subprovince alternative frameworks into coastwide alternatives was the availability of Mississippi River system resources in the form of freshwater. The Districts Hydraulics and Hydrologic Engineering Branch personnel estimated the amount of available Mississippi River flow for diversion. The combinability criteria identified that combination of subprovince frameworks that would exceed available resources to implement them. Future studies will be preformed early in the next phase to verify the total amount of river flow that can be diverted without adversely impacting the system.

6.3 Hydraulic Combinability Criteria

Monthly median flows for each diversion were developed for use by the Numerical Modeling Team. These flows were used for the water budget and estimates of induced shoaling on the Mississippi River. Monthly median flows for existing diversions at Davis Pond, Caernarvon, Naomi Siphon, and West Pointe a la Hache were also computed. Monthly median flows for the approved West Bay Sediment Diversion, a first year CWPPRA project, were also included in the analysis; it was assumed that the diversion was full size, or 50,000 cfs diversion at the 50 percent exceedence stage.

The monthly median Mississippi River flow at Tarbert Landing was developed from calendar year computed flow records for 1993-2002. The flows were adjusted, where necessary, to ensure representation of present operation of the Old River Control Complex at 70-30 latitude flow. These flows represented the amount of water in the Mississippi River available for diversion.

The flows for each diversion were organized by Mississippi River mile, from upstream to downstream for each alternative. For each subprovince framework, the monthly median flow through a diversion was subtracted from the Mississippi River monthly median flow present upstream of the diversion to produce the Mississippi River monthly median flow downstream of the diversion. This process was continued from the most upstream diversion for each alternative downstream to Venice, mile 10.7 AHP.

The frameworks for Subprovinces 1 and 2 represent the full extent of proposed diversions from the Mississippi River. As a result, for a Mississippi River water budget, it is necessary to combine flows from one alternative from Subprovince 1 with flows from one alternative from Subprovince 2, which produces 81 possible combinations of alternatives. The flows for each alternative were then added to produce all of the possible combined diversion flows to subtract from the monthly median flow at Tarbert Landing, resulting in a flow at Venice for the alternative combination.

A fixed percent diverted was computed for the West Bay Sediment Diversion based on the monthly median flow and the flow available upstream of this diversion. This percentage was applied to the flow at Venice for each framework combination to achieve the flow remaining in the Mississippi River. The ratio of the monthly median flow diverted to the monthly median flow at Tarbert Landing for June was developed for the alternative framework combinations.

The April 1990 report Louisiana Coastal Area, Louisiana, Feasibility Study on Land Loss and Marsh Creation, Volume 2, appendix B, contains annual shoaling estimates for the Mississippi River navigation channel for large-scale and small-scale diversions ranging from 594 cfs to 100,000 cfs at the 50 percent exceedence stage. These shoaling estimates were plotted with the percent diversion flow, and a power curve fit through the points. The resulting equation,

$$Y = 1.087E^{7} * X^{1.149}$$

where Y = annual shoaling estimate (cubic yards) and X = percent Tarbert flow diverted at the 50 percent exceedence stage (cfs) has an R^2 of 0.98. This equation was applied to the framework combination percentages to compute the shoaling estimate for each framework combination.

An upper bound trendline was developed for the shoaling estimate data from the April 1990 report. The resulting equation,

$$Y = 1.5E^{7} * X + 1.94E^{-9}$$

was also applied to the framework combination percentages to compute the shoaling estimate for each alternative combination to produce a potential shoaling range. An additional maintenance cost for each framework combination was developed based on these shoaling estimates and was entered into IWR-Plan as an additive cost to be applied to the specific framework combinations.

The CE/ICA was done using implementation costs (construction and real estate acquisition) traded against ecological benefit output units. The comparison of the coastwide frameworks was based on the summation of subprovince framework ecological benefits versus cost as provided by the IWR-Plan analysis. The CE/ICA was used to filter the coastwide frameworks down to an array of the ten most cost-effective. These frameworks were presented in four public meetings held across coastal Louisiana in August 2003.

A description of the economic values to be lost in the future without-project condition was also developed. A database from a previous USACE report was used to determine the potential economic impact of erosion. This database contains stage-damage data that were aggregated on the basis of water resource units (WRUs), delineations of the region where areas are grouped by economic and hydrologic characteristics. The stage-damage data for each WRU were developed in 1980 under contract with CH2M Hill Inc., as part of the Mississippi River and Tributaries (MR&T) Flood Damage Estimation System. The structural damage categories for each WRU include: residential, commercial, industrial, public, and farm buildings. After receiving an existing and future condition stage associated with each WRU provided by Hydrology and Hydraulics (H&H) Branch, the damages for the structural damage categories adjusted to current price levels by using price indexes from the Engineering News Record (ENR). For the agricultural portions of the study area, the database includes the cleared acreage flooded along with the crop distribution per cleared acre for each WRU. Updated damage rates per acre will then be obtained from previous studies to determine to the total agricultural damage for a given elevation or stage. The agricultural damages will be added to the structural damage at a given stage to estimate the total potential economic impact of coastal erosion.

To the extent possible, potential economic impacts of the frameworks were grossly estimated and taken into consideration in the selection. After the CE/ICA was completed, both positive and negative economic impacts in this final array were estimated on a gross basis to inform decision makers of the magnitude of any economic effects of the final frameworks.

For the development of the final array, cost-effectiveness criteria were also applied. The combined weighted ecological outputs provided by the models and benefit protocols were documented for each coastwide framework. The combined weighted outputs and costs for each framework was also displayed and ordered by cost. The decision factors provided the basis for the premises that describe the various changes that occur across the coast and the programmatic issues that were of importance to the framework selection process. The primary factors of interest were ecological benefit versus cost, and an assessment of economic effects. Six benefit groups analyzed these factors from the perspective of their expertise. The groups looked at: 1) Ecosystem Quality; 2) Composite Benefits; 3) Land (acres) Created or Preserved; 4) Weighted Fish and Wildlife Benefits; 5) Nitrogen (N) Removal; and 6) Values Determined by Decision Makers.

6.4 Framework Effectiveness

6.4.1 <u>Introduction</u>

The PDT utilized the data developed through the analyses to assess the effectiveness of the various frameworks. The model and benefit analyses focused on the individual framework combinations developed in each of the four subprovinces. Outputs from these tools provided specific assessments of the relative effectiveness of the frameworks at meeting the study objectives at the subprovince level.

6.4.2 Comparison of Frameworks

6.4.2.1 Framework outputs by subprovince

Given the programmatic nature of the LCA Plan, it was understood that the results of the modeling effort would serve primarily to differentiate among alternatives with respect to their relative effects on important resources. The LCA PDT acknowledges that the model-based projections for fish and wildlife outputs may not accurately forecast change. It was further understood that accurate estimates of the effects of particular restoration features could only be developed at the project level, when critical information such as the location, size, and operation of such features would be available. It is, however, believed that the model outputs are usable in the plan formulation process because they are derived from a consistent set of assumptions and protocols. Thus, the model outputs presented in this section do allow for measure of the incremental differences between alternatives.

The outputs for each of the 32 frameworks in the four subprovinces are represented below in several forms. These outputs provide the basis for determining the various benefit values described by the benefit protocols in the Plan Formulation Rationale section of this report. The bar graphs presented (**figures E-4 to E-22**) for the frameworks in each subprovince represent the components of environmental output that make up the benefit value described by the B2 benefit protocol. The B2 value was utilized to supply the benefit component of the cost effectiveness analysis, which is documented in the next section of this report. These desktop model outputs also provided a means of comparison of the relative effects of each framework.

A comparison of the year 50 habitat composition for the frameworks in each subprovince as compared to the No Action alternative at year 50 is presented in **tables E-9, E-12, E-15, and E-18**. Immediately following the habitat composition table in each subprovince is a table displaying the total production-vegetation graph for the frameworks in the respective subprovinces (**tables E-10, E-13, E-16, and E-19)**. This table displays the total anticipated productivity of vegetation in square kilometer production units as it is projected to change over 10-year increments for the 50-year planning period. Additionally, a table is provided, for each subprovince, of expected suitability for 12 individual species for each alternative within that subprovince, based on the conditions produced by each particular alternative framework (**tables E-11, E-14, E-17, and E-20)**.

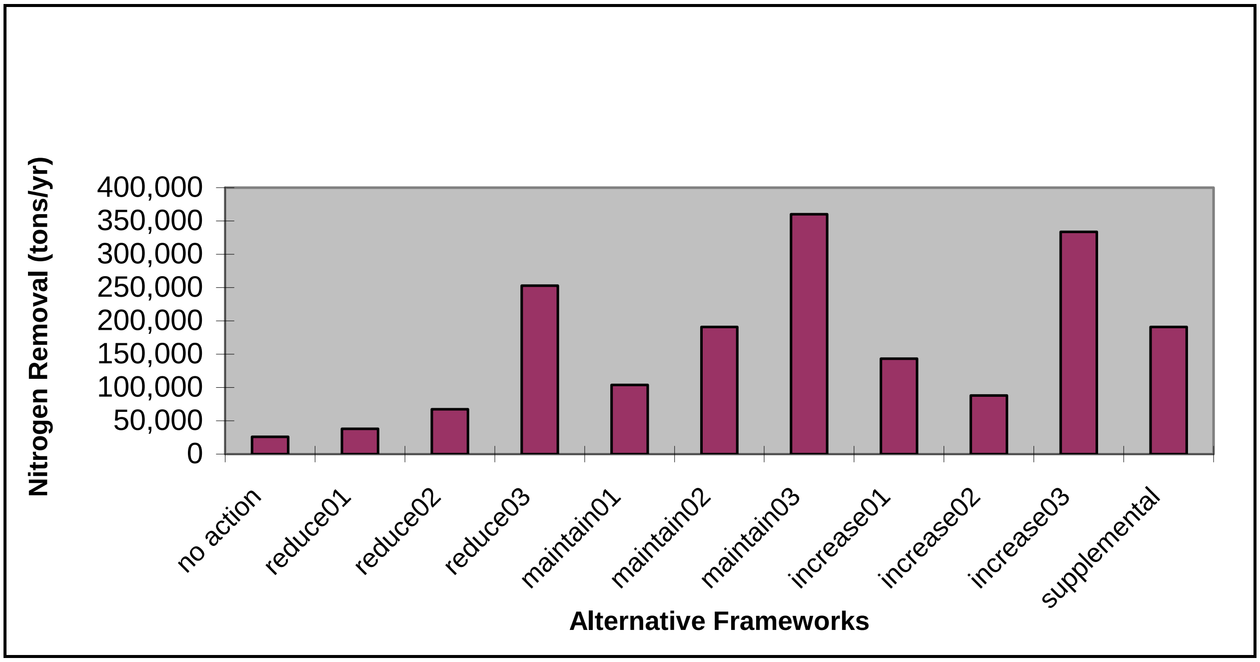


Figure E-4. Nitrogen Removal at Year 50 for Subprovince 1 Alternatives.

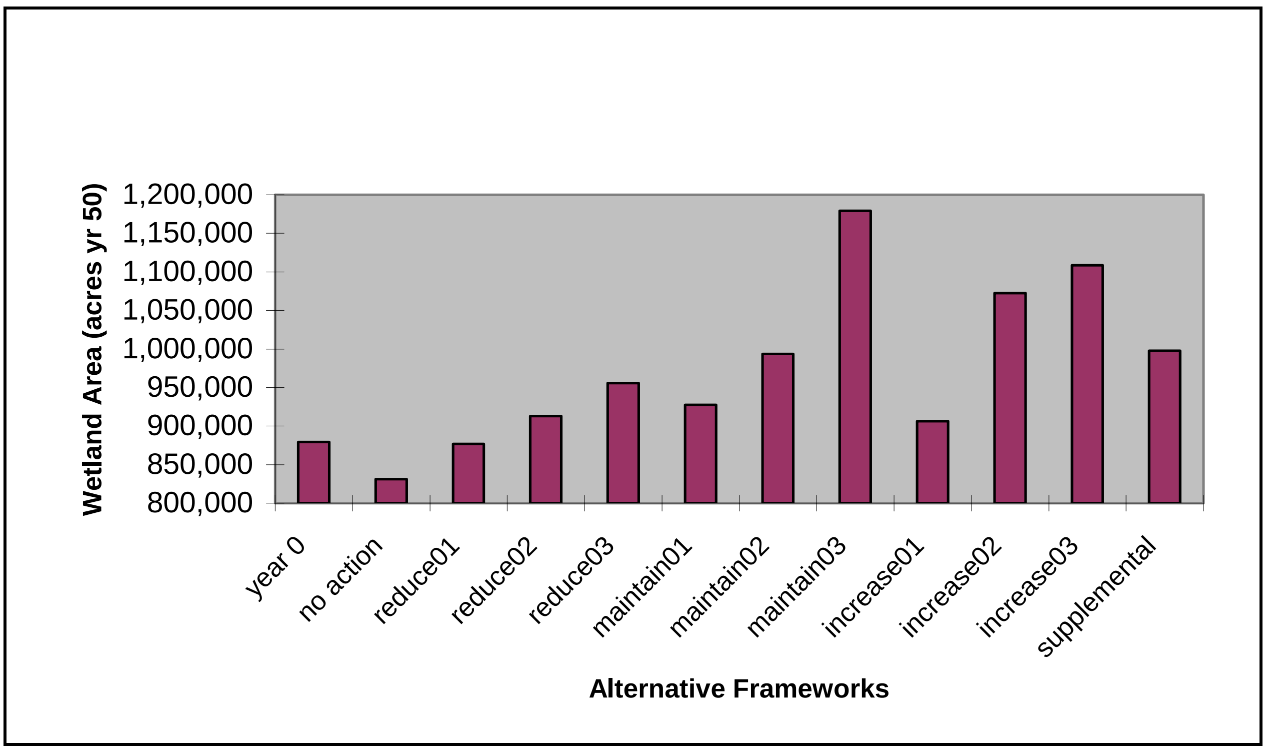


Figure E-5. Land Building at Year 50 for Subprovince 1 Alternatives.

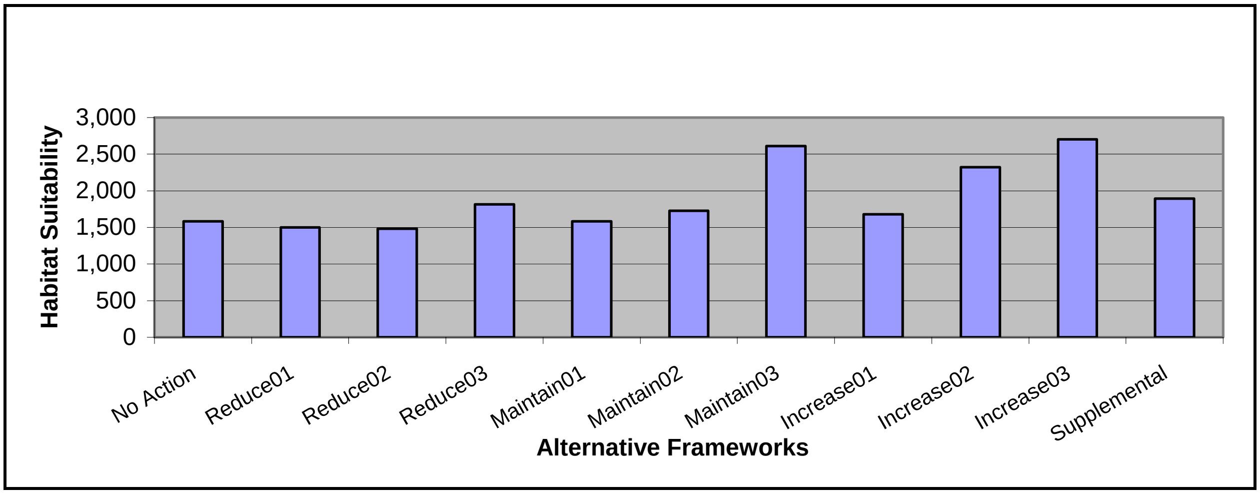


Figure E-6. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 1.

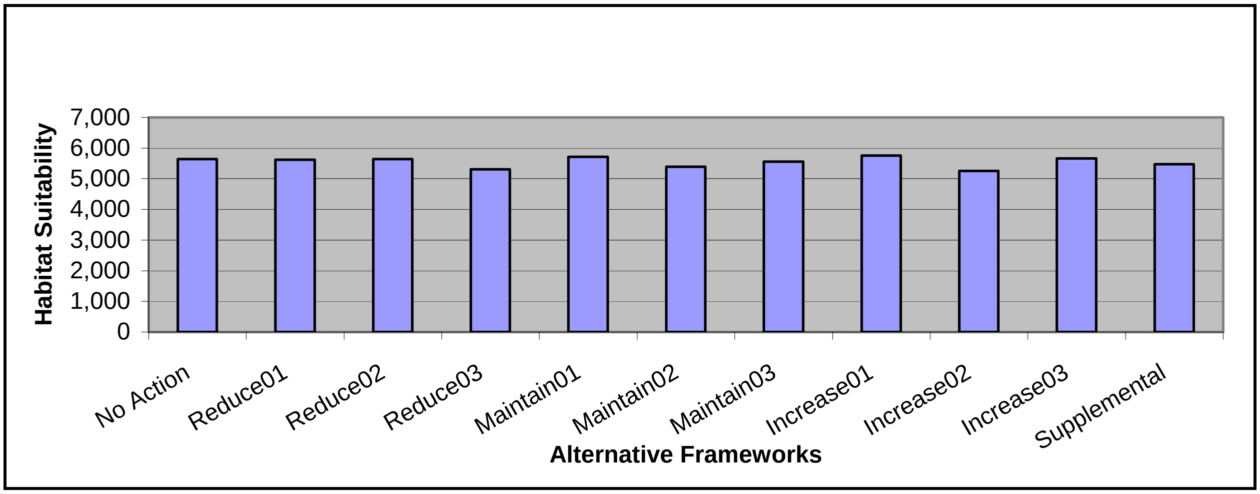


Figure E-7. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 1.

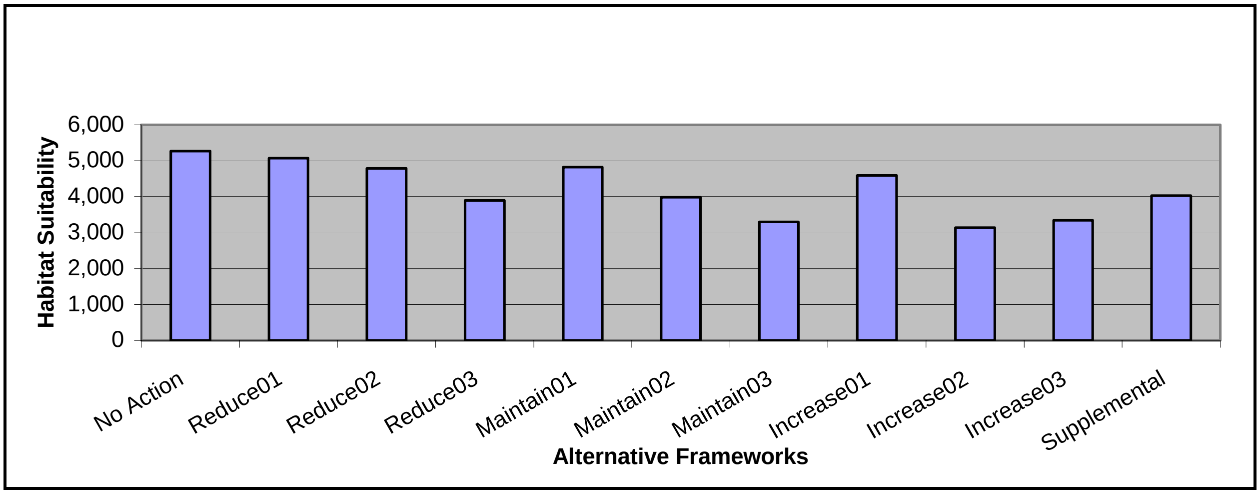


Figure E-8. Habitat Suitability for Higher Salinity Species at Year 50 for Subprovince 1.

Table E-9.
Percent Habitat Composition at Year 50 for Subprovince 1 Alternatives.

	Fresh Marsh	Intermediate Marsh	Brackish Marsh	Saline Marsh	Swamp	Upland	Water
No Action	5.7	2.7	3.9	1.5	9.0	14.0	63.2
Reduce 1	6.3	3.5	3.4	1.8	9.2	14.0	61.9
Reduce 2	6.8	3.4	4.3	1.5	9.1	14.0	60.9
Reduce 3	11.0	3.4	1.7	1.4	8.8	14.0	59.7
Maintain 1	6.3	4.0	5.0	1.4	8.8	14.0	60.5
Maintain 2	7.2	6.2	1.7	1.5	9.1	14.0	60.4
Maintain 3	19.4	3.4	1.3	0.0	8.3	14.0	53.6
Increase 1	6.6	3.2	2.6	3.0	9.2	14.0	61.1
Increase 2	14.6	4.3	1.4	0.6	8.7	14.0	56.5
Increase 3	17.0	3.4	1.3	0.6	8.2	14.0	55.5
Supplemental	8.3	7.4	1.7	1.4	8.7	14.0	58.6

Table E-10.
Total Production of Vegetation With the Subprovince 1 Alternatives (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	706.2	765.4	757.2	748.7	740.8	732.3
Reduce 1	706.2	789.4	788.6	787.1	783.9	781.4
Reduce 2	706.2	814.5	829.2	841.2	851.3	859.5
Reduce 3	706.2	867.4	905.2	941.1	973.8	1,006.0
Maintain 1	706.2	829.8	838.5	846.0	852.2	858.0
Maintain 2	706.2	833.5	860.3	884.2	905.4	923.7
Maintain 3	706.2	1,000.6	1,120.2	1,236.4	1,340.2	1,457.3
Increase 1	706.2	805.6	810.5	812.1	813.1	814.1
Increase 2	706.2	1,001.1	1,084.8	1,152.5	1,211.2	1,267.6
Increase 3	706.2	965.5	1,056.2	1,143.0	1,219.1	1,304.5
Supplemental	706.2	858.0	905.5	948.9	989.4	1,028.3

Table E-11.
Cumulative Habitat Suitability of Subprovince 1 Alternatives at Year 50.

	No Action	Reduce 01	Reduce 02	Reduce 03	Maintain 01	Maintain 02	Maintain 03	Increase 01	Increase 02	Increase 03	Supplemental
bass	19,875.1	19,284.2	18,988.5	24,375.3	19,227.2	24,142.5	30,279.9	22,037.2	29,680.6	31,515.5	24,537.5
croaker	44,691.8	44,659.4	44,809.1	43,297.2	44,851.0	43,585.3	43,044.0	45,173.8	42,971.6	43,591.2	43,272.4
trout	35,048.8	33,509.1	30,602.1	26,110.4	31,885.5	26,180.5	19,897.9	29,874.3	19,897.9	19,897.9	26,175.3
menhaden	44,570.6	44,502.4	44,762.4	41,010.9	44,933.6	42,230.6	39,458.4	45,303.7	37,641.7	39,868.5	42,237.8
brown shrimp	27,822.6	27,092.2	26,896.9	24,044.1	26,769.0	25,256.4	23,700.5	26,484.5	22,641.9	24,056.9	25,599.0
white shrimp	33,582.4	33,576.9	33,421.3	31,745.9	33,627.5	33,074.5	33,412.2	33,974.9	31,990.8	34,216.8	33,593.2
oyster	31,703.0	31,154.2	30,126.4	23,909.8	29,477.7	24,062.1	20,692.4	28,006.8	19,414.6	20,692.4	24,060.8
mink	6,652.9	6,220.9	6,393.5	6,640.9	6,595.5	6,424.5	7,391.0	6,518.5	7,239.8	7,514.5	6,592.9
otter	6,509.0	6,187.4	6,338.3	6,629.3	6,571.0	6,563.6	7,376.5	6,416.9	7,001.9	7,459.2	6,774.5
muskrat	11,641.6	11,658.4	12,183.8	12,035.5	12,697.0	11,475.5	14,353.0	12,072.3	13,350.3	13,973.2	12,195.5
alligator	5,696.9	5,917.6	5,875.3	6,197.4	6,334.7	6,624.0	8,848.5	5,601.4	7,281.9	8,885.3	7,619.4
duck	6,696.2	6,662.3	6,564.6	7,775.8	7,013.8	6,709.4	12,173.9	6,730.1	10,239.3	12,035.1	7,550.0

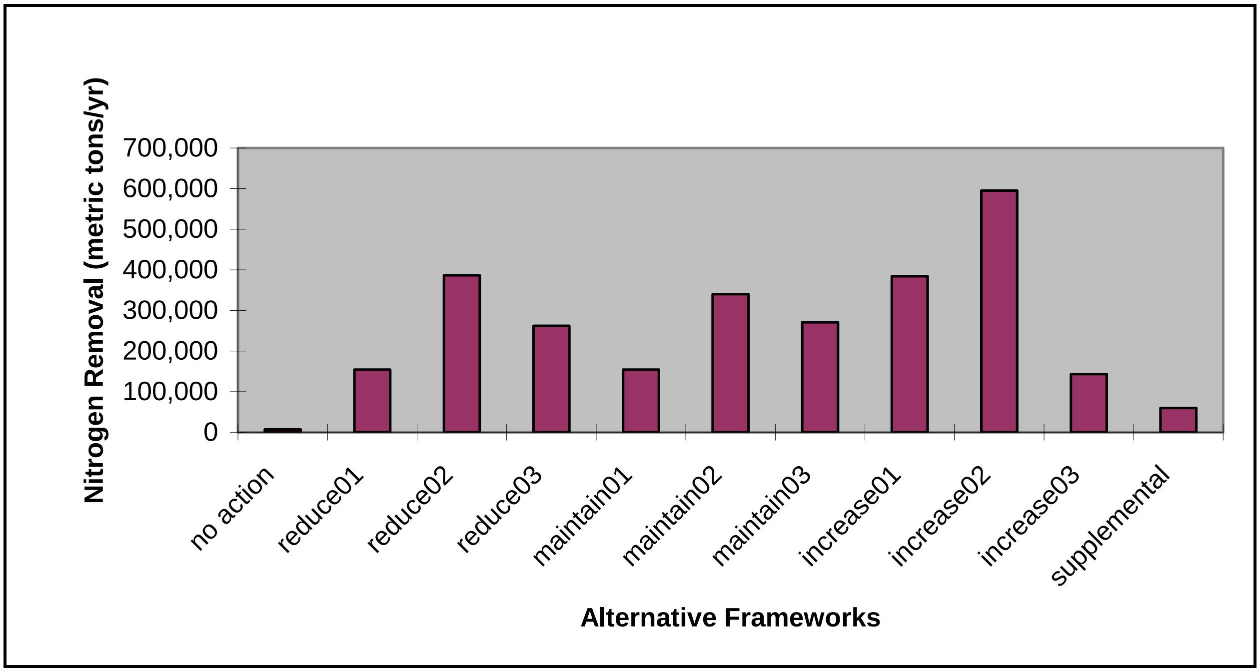


Figure E-9. Nitrogen Removal at Year 50 for Subprovince 2 Alternatives.

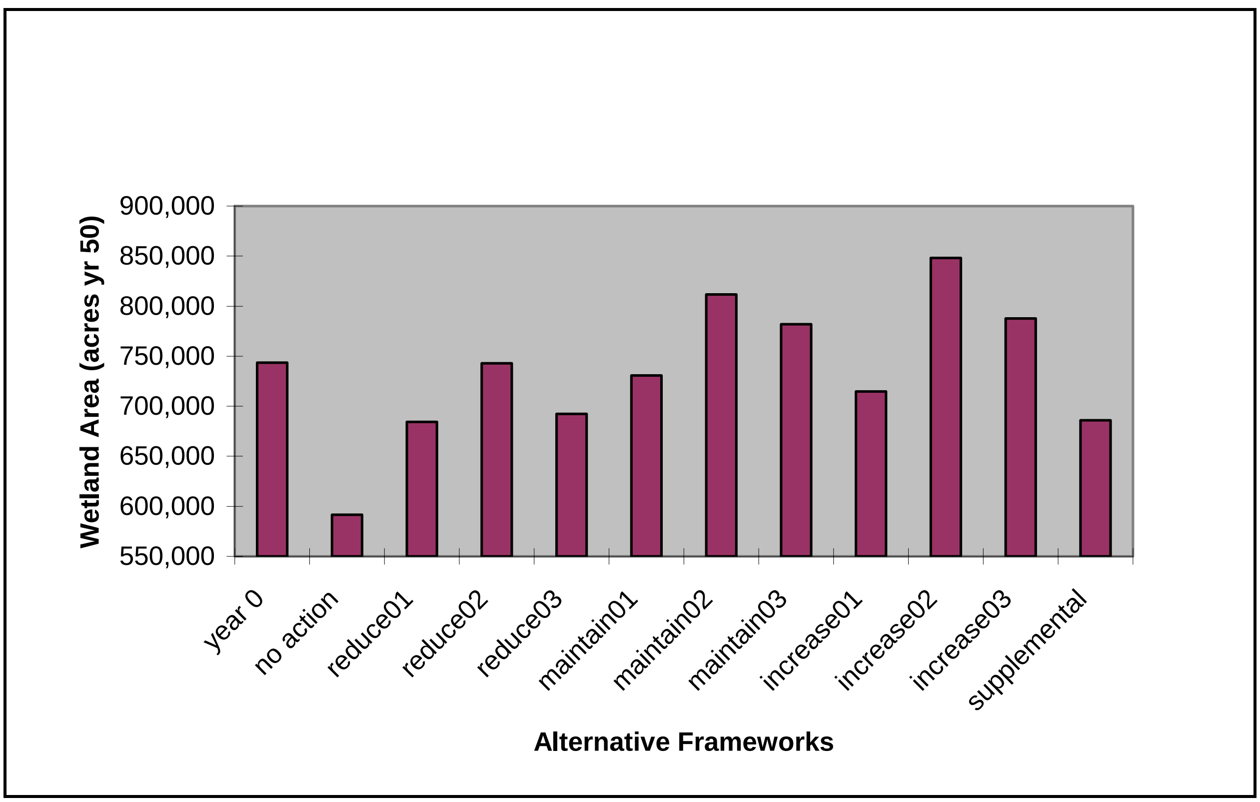


Figure E-10. Land Building at Year 50 for Subprovince 2 Alternatives.

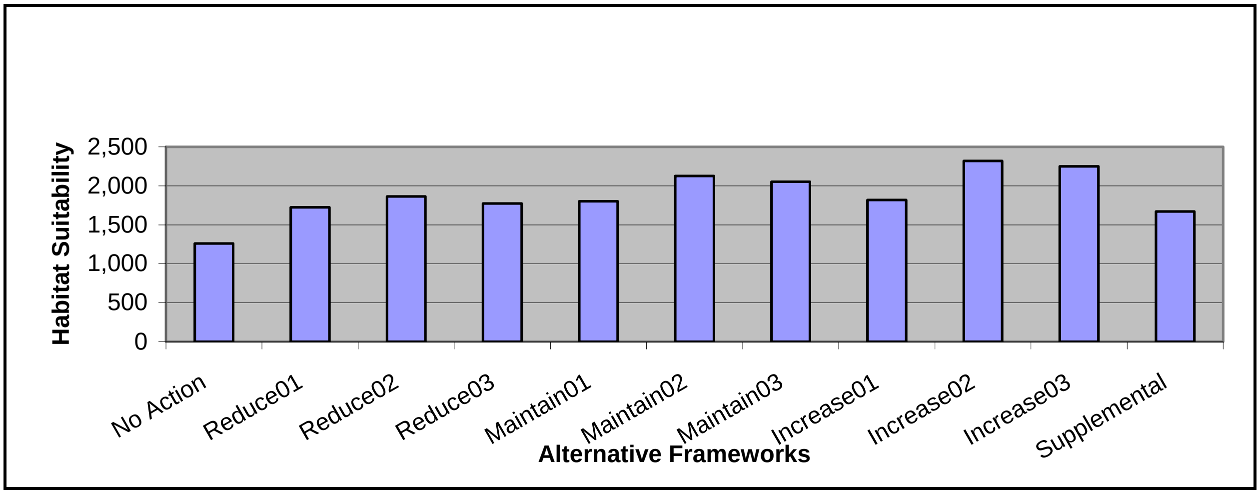


Figure E-11. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 2.

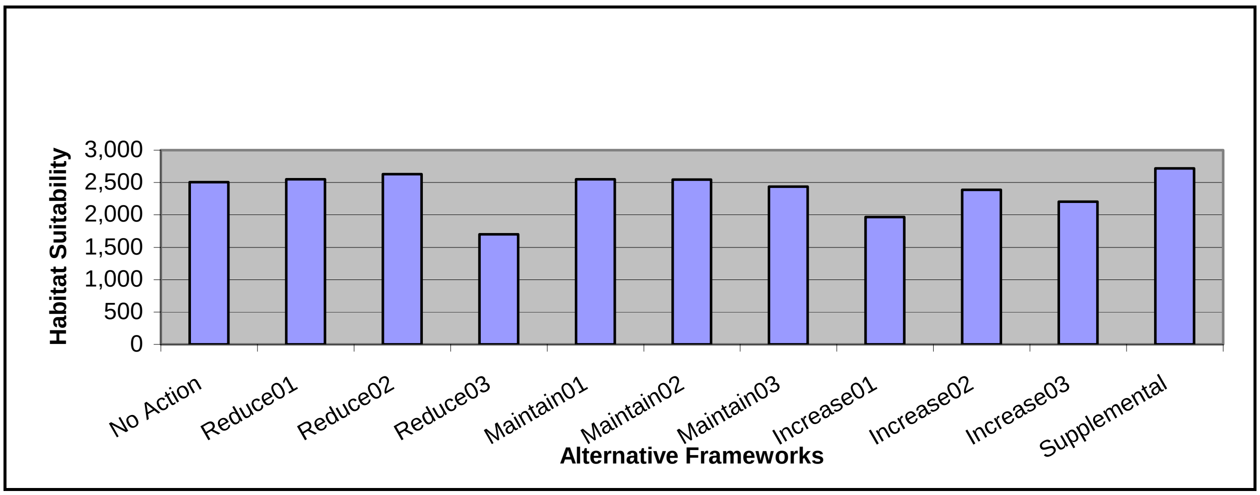


Figure E-12. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 2.

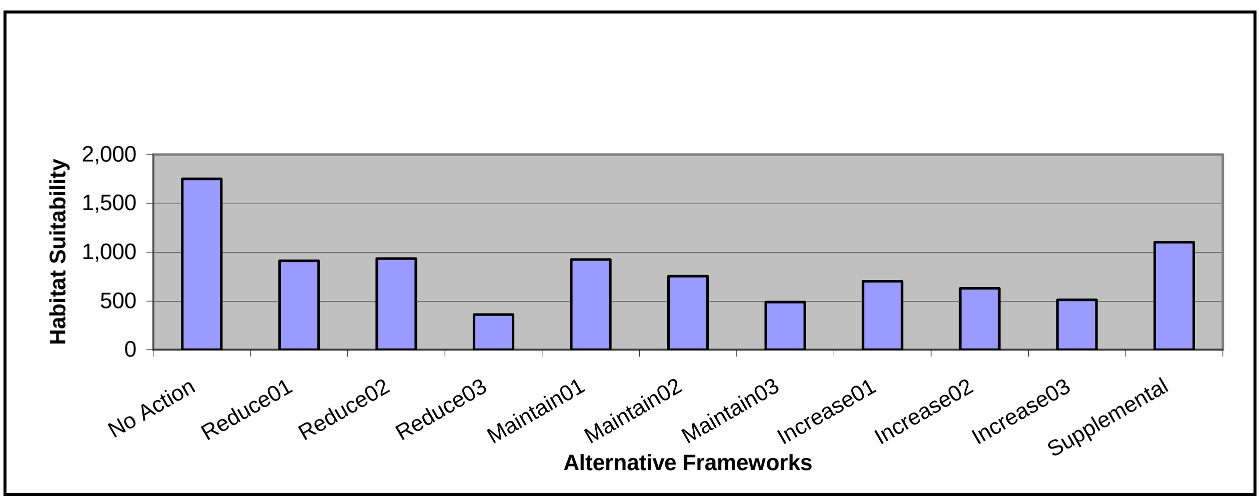


Figure E-13. Habitat Suitability for Higher Salinity Species at Year 50 for Subprovince 2.

Table E-12.
Percent Habitat Composition at Year 50 for Subprovince 2 Alternatives.

	Brackish Marsh	Fresh Marsh	Intermediate Marsh	Saline Marsh	Swamp	Upland	Water
No Action	0.0	14.2	2.9	0.0	15.9	18.1	48.9
Reduce 1	0.0	19.6	3.5	0.0	15.1	18.1	43.7
Reduce 2	0.0	23.7	3.3	0.0	14.4	18.1	40.4
Reduce 3	0.0	23.7	0.0	0.0	15.0	18.1	43.3
Maintain 1	0.0	22.1	3.8	0.0	14.8	18.1	41.1
Maintain 2	0.0	28.4	3.1	0.0	13.7	18.1	36.6
Maintain 3	0.0	28.6	1.1	0.0	13.9	18.1	38.3
Increase 1	1.1	24.2	0.0	0.0	14.6	18.1	42.0
Increase 2	0.0	34.1	0.0	0.0	13.2	18.1	34.6
Increase 3	0.0	27.2	3.8	0.0	12.9	18.1	37.9
Supplemental	0.0	16.1	6.8	0.0	15.3	18.1	43.6

Table E-13.
Total Production of Vegetation with the Subprovince 2 Alternatives (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	720.4	721.5	660.7	610.2	569.9	537.5
Reduce 1	720.4	819.8	788.9	755.6	731.2	709.0
Reduce 2	720.4	769.7	781.3	801.4	820.5	838.2
Reduce 3	720.4	856.7	827.0	803.8	785.0	771.5
Maintain 1	720.4	849.2	841.3	824.5	792.8	785.4
Maintain 2	720.4	863.0	879.1	905.3	934.1	965.7
Maintain 3	720.4	869.0	873.2	885.4	899.5	921.5
Increase 1	720.4	869.9	880.0	852.6	838.0	823.1
Increase 2	720.4	935.2	978.5	1,031.5	1,072.0	1,074.0
Increase 3	720.4	827.3	876.2	908.1	840.5	969.5
Supplemental	720.4	806.2	788.0	752.9	719.1	683.8

Table E-14.
Cumulative Habitat Suitability of Subprovince 2 Alternatives at Year 50.

	No Action	Reduce 01	Reduce 02	Reduce 03	Maintain 01	Maintain 02	Maintain 03	Increase 01	Increase 02	Increase 03	Supplemental
bass	20,420.3	22,595.3	22,831.7	23,621.8	22,665.4	24,578.0	24,464.6	23,056.1	25,679.4	24,723.1	21,593.0
croaker	18,430.1	15,967.8	15,857.0	13,786.5	15,681.4	15,006.1	14,227.3	14,808.8	13,755.1	13,825.1	17,630.3
trout	3,335.3	2,762.0	2,758.5	558.2	2,762.0	558.2	558.2	2,610.4	558.2	558.2	4,713.7
menhaden	18,200.1	15,275.3	15,252.6	8,611.7	15,092.9	13,754.0	12,835.5	10,453.2	11,775.5	12,034.9	17,802.2
brown shrimp	14,168.0	12,545.8	12,724.6	7,201.0	12,621.4	12,672.6	9,073.6	9,566.7	10,874.1	9,209.5	13,564.8
white shrimp	20,226.7	20,460.2	20,807.0	12,095.2	20,039.7	19,850.7	19,792.4	14,096.9	18,644.3	15,678.8	19,908.7
oyster	3,213.4	1,206.8	1,225.1	513.7	1,206.8	513.7	513.7	1,304.6	513.7	513.7	1,193.8
mink	6,039.4	6,447.6	6,487.7	6,531.9	6,630.3	6,864.7	6,785.2	6,700.3	7,155.8	7,314.2	6,373.9
otter	5,858.3	6,336.8	6,362.3	6,209.6	6,520.6	6,742.7	6,533.8	6,365.7	6,758.7	7,050.8	6,376.7
muskrat	7,740.1	8,777.1	9,320.9	9,002.8	9,268.5	10,293.0	10,121.2	9,806.5	11,009.2	9,896.9	8,690.3
alligator	4,194.2	5,123.0	5,401.3	4,238.6	5,388.5	6,135.3	5,416.9	4,579.2	5,888.2	5,267.1	5,324.3
duck	5,924.8	7,126.8	7,958.8	7,678.5	7,468.3	9,448.3	9,500.2	8,007.9	11,441.9	9,277.7	6,544.9

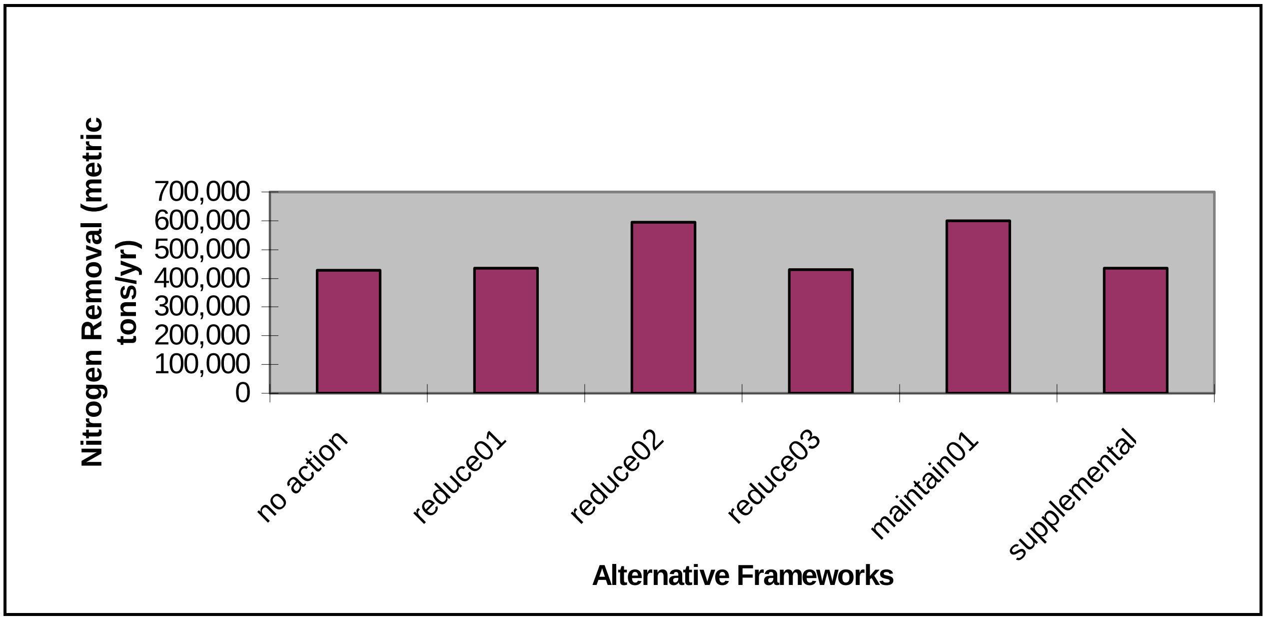


Figure E-14. Nitrogen Removal at Year 50 for Subprovince 3 Alternatives.

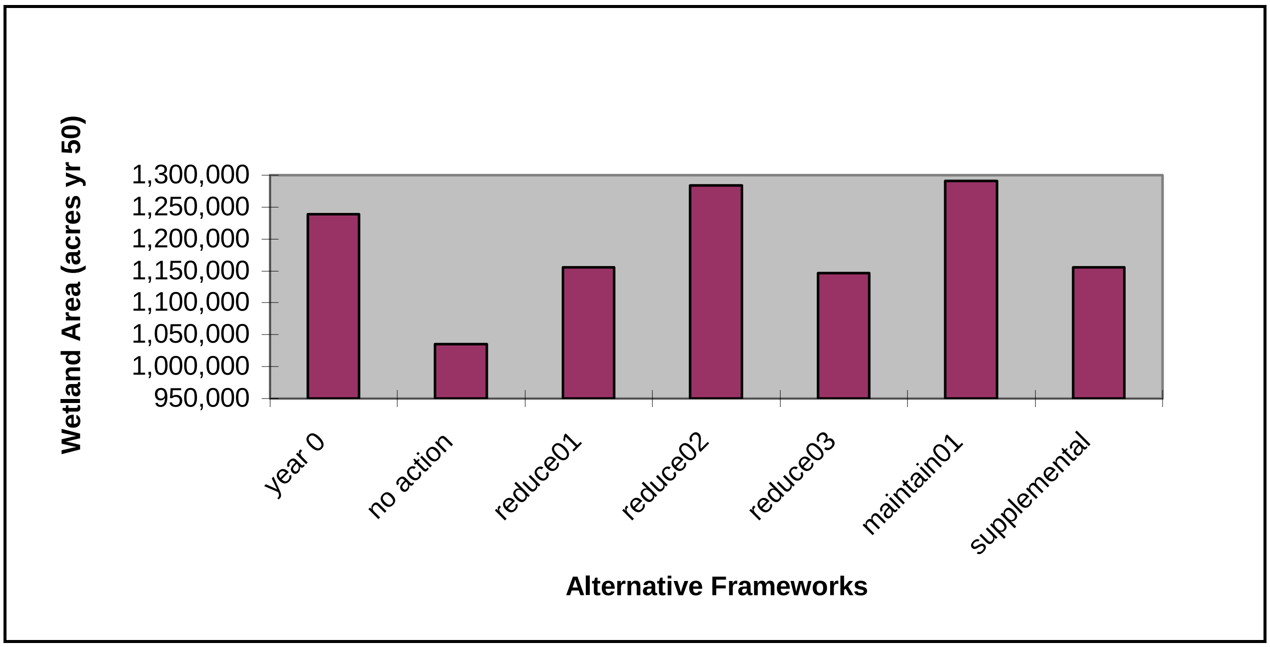


Figure E-15. Land Building at Year 50 for Subprovince 3 Alternatives.

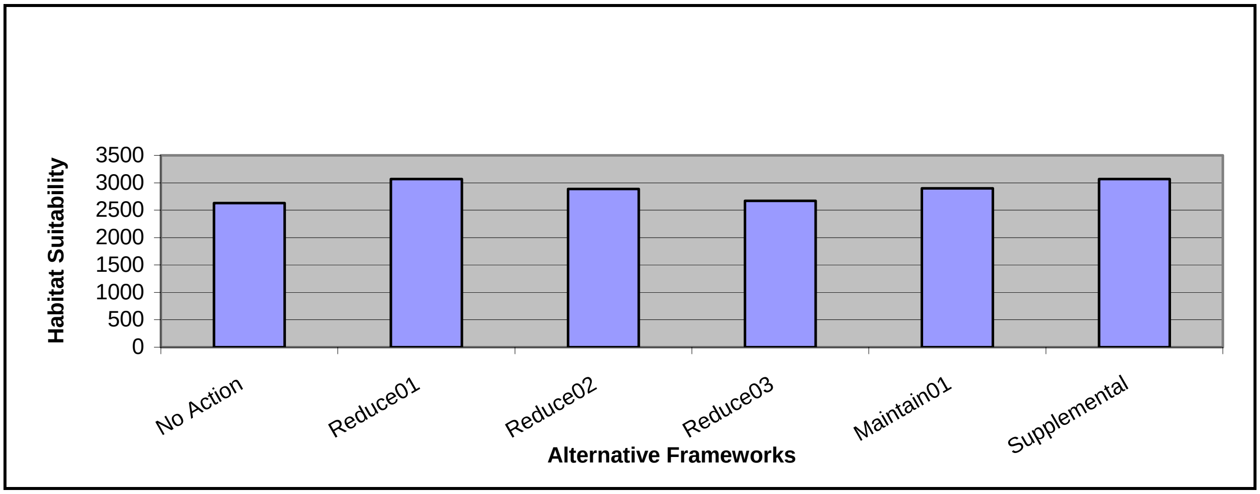


Figure E-16. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 3.

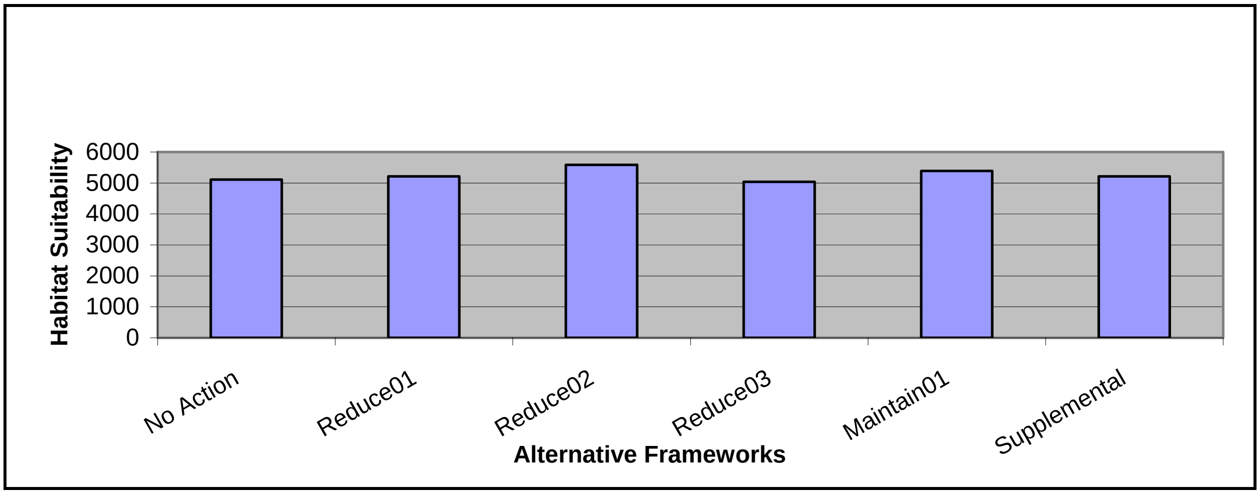


Figure E-17. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 3.

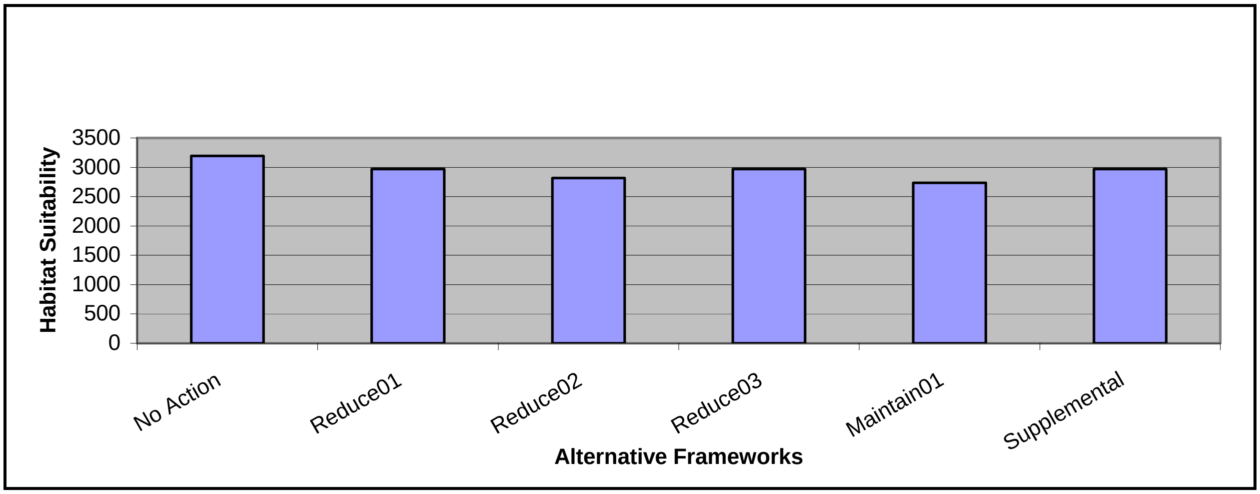


Figure E-18. Habitat Suitability for Higher Salinity Species at Year 50 for Subprovince 3.

Table E-15.
Percent Habitat Composition at Year 50 for Subprovince 3 Frameworks.

	Brackish Marsh	Fresh Marsh	Intermediate Marsh	Saline Marsh	Swamp	Upland	Water
No Action	1.5	1.2	22.8	0.2	12.4	10.0	51.9
Reduce 1	1.2	6.5	22.3	0.6	12.0	10.0	47.4
Reduce 2	7.3	6.2	22.3	0.0	11.5	10.0	42.7
Reduce 3	1.2	6.5	22.0	0.6	12.0	10.0	47.8
Maintain 1	7.3	8.9	19.6	0.0	11.8	10.0	42.5
Supplemental	1.2	6.5	22.3	0.6	12.0	10.0	47.4

Table E-16.
Total Production of Vegetation with the Subprovince 3 Frameworks (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	1,570.9	1,512.5	1,414.1	1,306.1	1,202.2	1,106.2
Reduce 1	1,570.9	1,517.1	1,458.0	1,417.0	1,374.3	1,338.0
Reduce 2	1,570.9	1,635.6	1,643.0	1,649.1	1,666.4	1,693.0
Reduce 3	1,570.9	1,516.2	1,463.2	1,408.2	1,361.1	1,320.4
Maintain 1	1,570.9	1,686.9	1,694.5	1,701.9	1,717.3	1,746.3
Supplemental	1,570.9	1,517.1	1,468.0	1,417.0	1,374.3	1,338.0

Table E-17.
Cumulative Habitat Suitability of Subprovince 3
Alternatives at Year 50.

	No Action	Reduce 01	Reduce 02	Reduce 03	Maintain 01	Supplemental
bass	32,637.6	31,970.4	31,955.1	31,866.1	31,982.4	31,970.4
croaker	31,255.1	30,562.8	31,356.3	30,527.9	30,185.8	30,562.8
trout	17,684.0	15,468.3	15,596.3	15,473.4	15,617.5	15,468.3
menhaden	36,848.0	35,699.2	38,880.6	35,587.1	36,717.4	35,699.2
brown shrimp	27,767.3	26,890.0	28,010.5	26,831.1	26,666.5	26,890.0
white shrimp	37,917.5	37,221.0	39,239.3	37,088.7	38,396.9	37,221.0
oyster	10,837.4	10,733.5	6,449.5	10,733.5	6,447.9	10,733.5
mink	8,761.2	9,983.5	9,075.7	8,386.8	9,207.8	9,983.5
otter	9,638.0	11,107.0	9,853.1	9,182.6	9,799.6	11,107.0
muskrat	14,609.9	17,672.3	18,076.3	15,537.3	18,344.8	17,672.3
alligator	14,933.3	15,811.3	16,242.1	14,554.9	15,479.3	15,811.3
duck	10,224.6	12,540.2	12,672.3	10,992.1	13,231.3	12,540.2

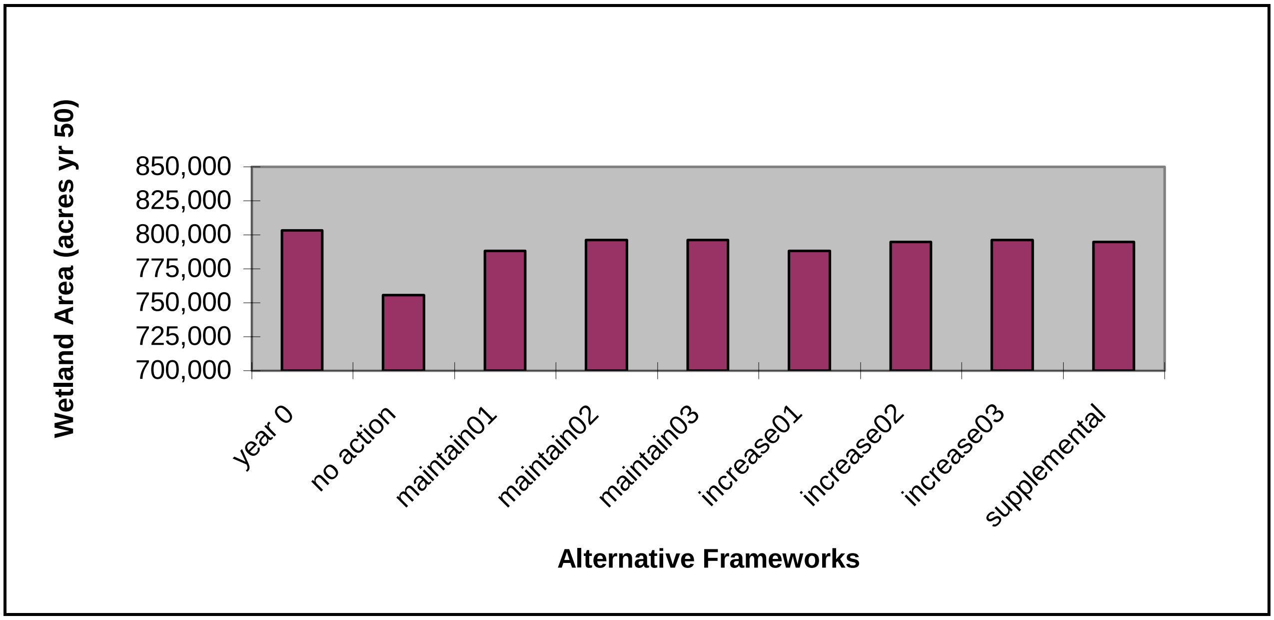


Figure E-19. Land Building at Year 50 for Subprovince 4 Alternatives.

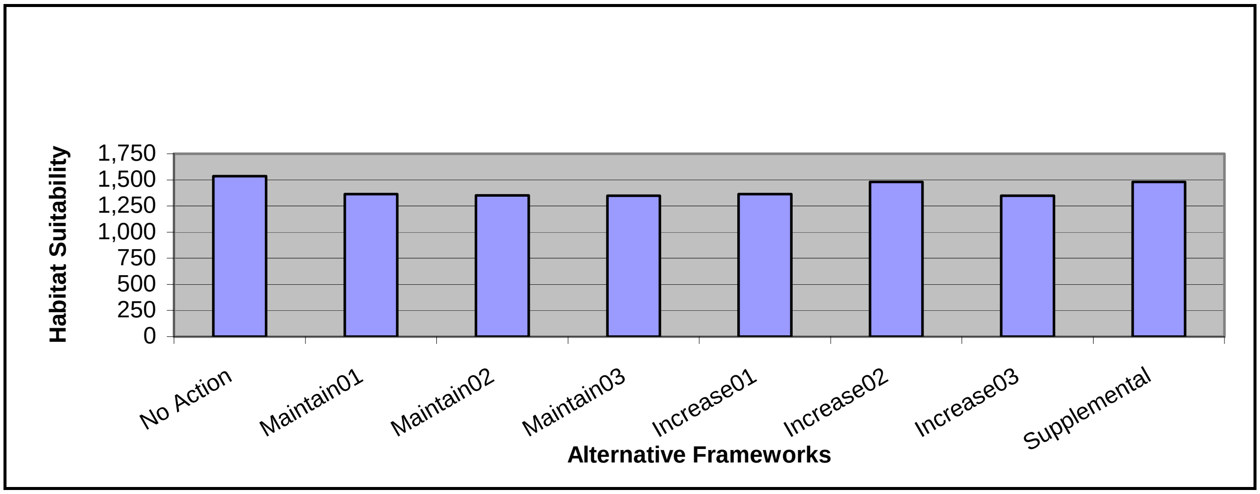


Figure E-20. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 4.

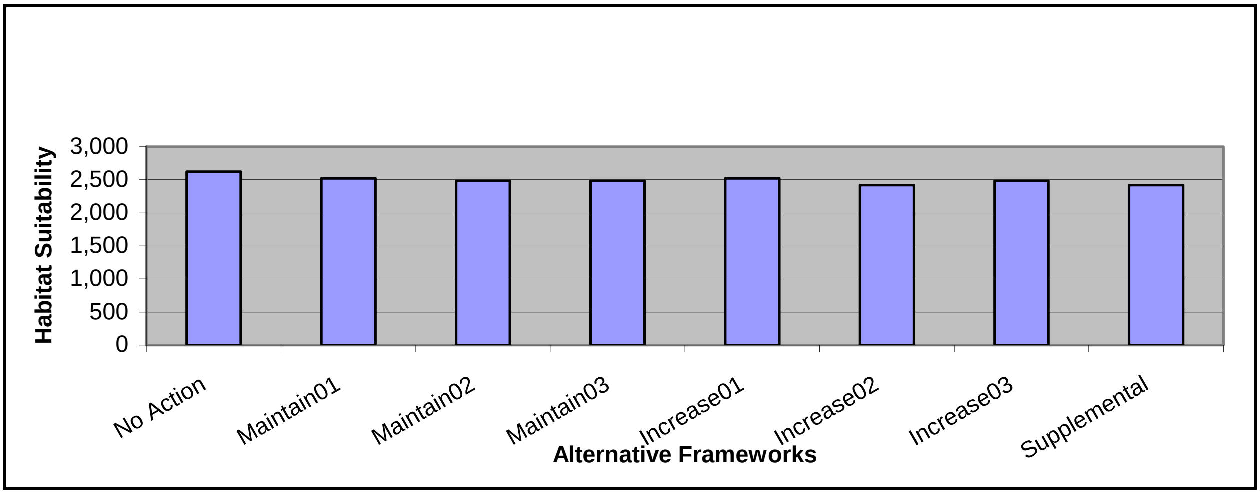


Figure E-21. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 4.

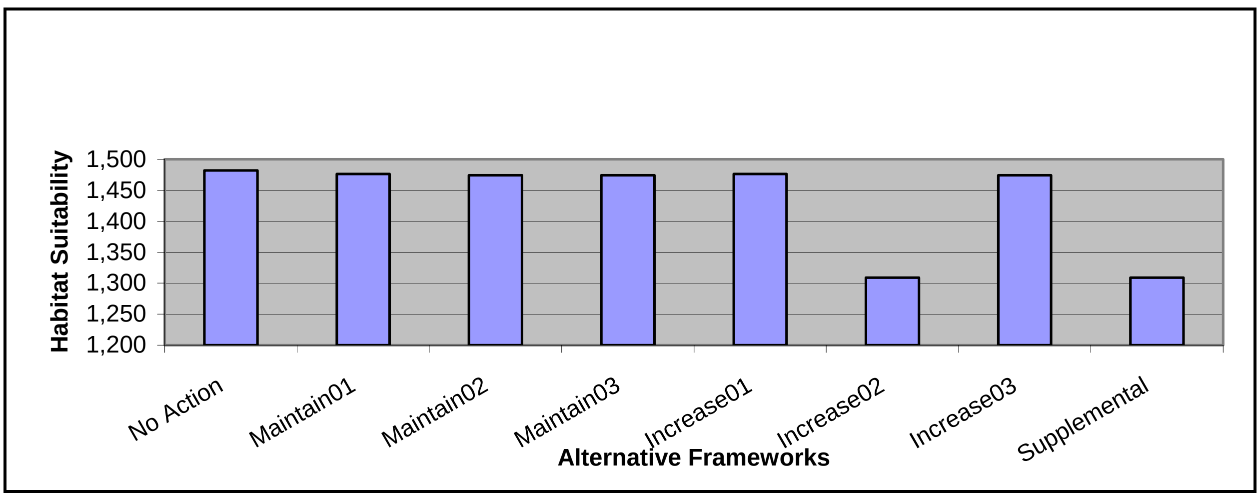


Figure E-22. Habitat suitability for Higher Salinity Species at Year 50 for Subprovince 4.

Table E-18.
Percent Habitat Composition at Year 50 for Subprovince 4 Alternatives.

	Brackish Marsh	Fresh Marsh	Intermediate Marsh	Saline Marsh	Swamp	Upland	Water
No Action	14.8	22.9	17.4	0.0	0.2	11.5	33.2
Maintain 1	14.9	20.3	22.3	0.0	0.2	11.5	30.9
Maintain 2	15.2	20.4	22.4	0.0	0.2	11.5	30.3
Maintain 3	15.3	20.4	22.4	0.0	0.2	11.5	30.3
Increase 1	14.9	20.3	22.3	0.0	0.2	11.5	30.9
Increase 2	11.4	23.9	22.7	0.0	0.2	11.5	30.4
Increase 3	15.3	20.4	22.4	0.0	0.2	11.5	30.3
Supplemental	11.4	23.9	22.7	0.0	0.2	11.5	30.4

Table E-19.
Total Production of Vegetation with the Subprovince 4
Alternatives (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	1,507.2	1,558.4	1,552.1	1,521.0	1,494.8	1,470.8
Maintain 1	1,507.2	1,522.8	1,514.4	1,483.9	1,457.3	1,433.5
Maintain 2	1,507.2	1,516.8	1,510.3	1,480.3	1,453.8	1,430.0
Maintain 3	1,507.2	1,517.1	1,510.6	1,481.6	1,454.1	1,430.3
Increase 1	1,507.2	1,533.8	1,514.4	1,483.9	1,457.3	1,433.5
Increase 2	1,507.2	1,531.7	1,527.8	1,497.7	1,471.7	1,448.4
Increase 3	1,507.2	1,517.1	1,510.6	1,480.6	1,454.1	1,430.3
Supplemental	1,507.2	1,531.7	1,527.8	1,497.7	1,471.7	1,448.4

Table E-20.
Cumulative Habitat Suitability of Subprovince 4 Alternatives at Year 50.

	No Action	Maintain 01	Maintain 02	Maintain 03	Increase 01	Increase 02	Increase 03	Supplemental
bass	13,787.9	11,446.0	11,446.0	11,446.0	11,446.0	13,663.3	11,446.0	13,663.3
croaker	13,791.7	13,350.9	13,212.7	13,213.5	13,350.9	13,212.7	13,213.5	13,212.7
trout	10,337.0	12,173.1	11,986.5	11,986.5	12,173.1	9,491.4	11,986.5	9,491.4
menhaden	15,631.9	15,357.1	15,175.5	15,180.6	15,357.1	14,726.7	15,180.6	14,726.7
brown shrimp	12,866.3	12,049.6	11,929.9	11,940.7	12,049.6	11,990.1	11,940.7	11,990.1
white shrimp	17,794.6	17,547.7	17,321.7	17,321.7	17,547.7	16,893.0	17,321.7	16,893.0
oyster	2,422.5	1,801.7	2,222.4	2,227.1	1,801.7	2,168.8	2,227.1	2,168.8
mink	6,492.3	6,259.2	6,214.5	6,214.0	6,259.2	6,322.8	6,214.0	6,322.8
otter	7,111.4	6,943.0	6,899.5	6,895.7	6,943.0	7,116.9	6,895.7	7,116.9
muskrat	13,583.0	13,397.5	13,405.1	13,417.7	13,397.5	12,871.5	13,417.7	12,871.5
alligator	8,435.9	8,266.2	8,150.2	8,147.4	8,266.2	8,326.1	8,147.4	8,326.1
duck	7,444.1	6,917.8	6,845.6	6,845.4	6,917.8	7,073.8	6,845.4	7,073.8

6.5 Cost Effectiveness/Incremental Analysis

6.5.1 Overview

This study evaluated several frameworks designed to preserve coastal habitat and functions now recognized as a vital national resource. The intent is to save these important resources in a manner that also sustains or increases other economic resources that are the traditional focus of the Federal water resource program. The benefits of the various frameworks are defined in non-monetary units, as previously described. Benefits for most of the study area are evaluated using a qualitative and quantitative metric that assesses each alternative's contribution to the stock of natural resources. In the Chenier Plain portion of the study area, benefits are measured more simply in acres of land preserved or restored. Since these features are not readily translatable to dollar terms, traditional benefit-cost analysis is not possible. Consequently, a method that allows the comparison of benefits measured in these metrics mentioned above and costs measured in dollars was performed and is referred to herein as CE/ICA.

6.5.2 Methodology

A number of restoration frameworks were developed for various portions of the coastal area. Individual sets of frameworks were evaluated on their own and as possible combinations. In forming these combinations, three types of interactions were taken into account: exclusions, dependencies, and synergistic effects.

In several instances, many of the proposed frameworks could not be combined (i.e., they are mutually exclusive). In some cases, the exclusion exists because the alternatives occupy the same space. For example, more than one flow regime may be evaluated at the same location. In other cases, some alternatives cannot function without other frameworks in place, i.e., they are dependent on other frameworks. Likewise, synergistic features may produce more or less benefit when combined with other frameworks. Each type of interaction was addressed during the evaluation of alternatives.

The costs and benefits of the frameworks were amortized over a 50-year period of analysis at the current Federal discount rate of 5.875 percent. Costs were estimated at the October 2003 price level. Engineering and design, and supervision and administration costs were not available when the cost-effectiveness analysis was completed. However, since these charges are a fixed percentage of construction costs for all alternatives and the projects have similar construction schedules, their inclusion would be unlikely to influence project selection, i.e., the relative ranking of projects should be unaffected by the omission. The only consequential effect is a fairly uniform understatement of the cost of all alternatives.

6.5.3 Cost Effectiveness Assessment

In the cost-effectiveness analysis, the coastwide frameworks were assessed according to their ability to produce output for a given cost level. The frameworks that maximized output per dollar spent were retained, while those alternatives that did not were eliminated. The result was a listing of frameworks that would achieve each output level at the lowest cost, or an "efficient frontier." Restated, alternative frameworks screened in this manner met these two tests: (1) no other solution produces the same output for less cost, and (2) no other solution provides more output for the same or less cost.

The cost-effectiveness assessment was followed by an incremental cost analysis. Incremental cost is the additional cost for each increase in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated a process of evaluating the desirability of implementing the remaining frameworks in the absence of a strict guideline for determining the best outcome (such as maximizing net benefits, as is done in national economic development analysis). Potential economic impacts of the plans were roughly estimated and taken into consideration in project selection as follows: after CE/ICA, both positive and negative economic impacts of in the final array were estimated on a gross basis to inform decision makers of the magnitude of these effects.

6.5.4 Ecosystem Benefits (B2) Assessment

To generate benefit values for input to the cost-effectiveness analysis, one benefit number has been developed, termed "B2." This benefit number will indicate how well a particular alternative meets Ecosystem Objectives, and will indicate the alternative's effectiveness in creating or preserving land. This benefit protocol incorporates measurements of the quality and quantity of land created or preserved, as well as the capacity of each framework to remove nitrogen from river water before it reaches the gulf (see the Ecological Modeling Appendix, C, for further details).

6.5.5 Methodological Uncertainties

Readers should be aware of several important limitations to the data and methodology used herein. These limitations impacted the outcome of the analysis, and were considered when using the results for planning purposes. These limitations concern the benefits calculations, implementation costs, and NED impacts of the alternatives.

6.5.5.1 Benefits projections

This benefit protocol incorporates measurements of three variables: the quality of habitat produced, the quantity of land created or preserved, and the capacity of each framework to remove nitrogen from river water before it reaches the gulf. The outputs produced for each of these scaled benefit types were quantified for each alternative, and weights were assigned to establish the relative value of each of these three outputs. A consensus of professional judgment was used to determine the weighting of these benefit types, and an estimate of the composite factor B2 was produced for each feature. The weights are critical to the outcome of the analysis, i.e., the results could change greatly if the weighting factors were different.

As a procedural matter, since the weighting of scaled benefits was incorporated into the calculation of the B2 variable itself, B2 units were put directly into the computer program that was used to develop cost-effective frameworks. An alternate method would have been to put features of the benefit types directly into the program and place weighting factors on each of these outputs. The two methods would yield similar results.

The benefits model produced fairly small differentials in output for many alternative frameworks, and these small differentials may be beyond the capability of the modelers to predict with great certainty. Yet, the model differentiates between alternative frameworks with small benefit differences. For example, Alternative framework 7000 is predicted to produce 1,945 average annual benefit units per year. The next cost-effective alternative framework, 5010, would produce 1,987 units per year, a change of 42 units, or about 2 percent. Given the highly experimental nature of the benefits model, these frameworks may well be considered equal. Moreover, displaying the figures in this manner risks creating a false sense of precision in the process.

In addition, the reader should be aware that there also limitations noted regarding the calculation of the input values of quality of habitat, quantity of land, and nitrogen removal; each of these required inputs to the B2 protocol. Overall, these limitations mean that alternatives that contain large diversion features may have more uncertain estimates of land building, may underestimate nitrogen removal, and may overstate impacts to higher salinity habitats. The limitations to measurement of these three variables are outline below.

Quality of Habitat. Assessment of habitat quality includes estimates of habitat suitability for selected fish and wildlife species that use the estuary. Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" note that the box models used to estimate salinity changes across subprovinces mask salinity gradients within a box. Some of the species (birds, mammals, reptiles) respond more to the vegetated community type, while others (fish, shrimp, oysters) respond to changes in salinity along the estuarine gradient. This means that some species are more sensitive to abrupt changes in the salinity gradient due to model limitations. Habitat for species, which use higher salinity areas of the estuary, is thus likely underestimated, while moderate salinity habitat is probably over estimated. The assessment of habitat quality included in B2 includes categories for habitats in low, moderate, and higher salinity environments. To some extent the uncertainties in habitat suitability predictions may counteract one another, but it is likely that B2 values for framework including very large diversions are more uncertain than for others.

Quantity of Land. The features encompassed by the alternatives include very large diversions and small diversions, as well as mechanical marsh creation. As noted in the Ecological Modeling appendix, there are limitations to the land building and nourishment desktop models that will affect all sizes of diversions. In addition, they note that estimates of land building by mechanical means, such as using dredging or sediment conveyance by pipeline, are likely to be more accurate. However, it is unclear that these limitations should prejudice any broad scale consideration of the land building estimates for the subprovince alternatives. These limitations do, however, mean that relatively small differences in land building among frameworks are likely less important than overall trends.

Nitrogen Removal. The uncertainties in modeling identified by Appendix C "Hydrodynamic and Ecological Modeling: Louisiana Coastal Area Ecosystem Model" suggest that the nutrient reduction potential of very large river diversions is likely underestimated in the analyses presented here. They also note that there may be some, but much smaller in absolute magnitude, overestimates for smaller diversions.

6.5.5.2 Cost estimates

Cost estimates produced an accuracy level somewhat below that of a normal feasibility study. To the degree that these costs are misstated, the accuracy of the analysis is compromised.

6.5.6 Framework Analysis Results

The results of the CE/ICA analysis are presented below. Results for the Deltaic Plain are discussed together while the Chenier Plan was analyzed separately. A predominant selection criterion was the availability of river resources. Due to differences among habitat types and physical constraints, the study area was divided into two main areas for this assessment. The first area is an assembly of the Deltaic Plain, a series of alluvial plains. These areas were originally produced by the Mississippi River and its tributaries as these water bodies changed course over time. The preservation of these plains will depend on the same river system. Hence, achievement of any of these goals is constrained by the amount of water available in the river and tributary system. The Chenier Plain, in contrast, is not created by river water, and the creation and preservation of habitat in this area is not constrained by available river resources. Thus potential solutions for the Deltaic Plain are interdependent and should be considered together, while the Chenier Plain may be evaluated independently.

6.5.7 Initial Deltaic Plain Results

The first cost-effectiveness analysis examined combinations of alternatives that were developed for Deltaic Plain. These primarily consisted of river diversions of various sizes. Since most of these alternatives use significant amounts of river water, the optimization of the alternatives was done using a constraint on the total amount of water drawn from the river. The constraint was that the total amount of water drawn from the river was limited to 45 percent of the river's average flow based on diversion percentage data developed for each framework for conditions in the month of June.

Figure E-23 below provides an overview of the CE/ICA process used to evaluate the frameworks for the Deltaic Plain.

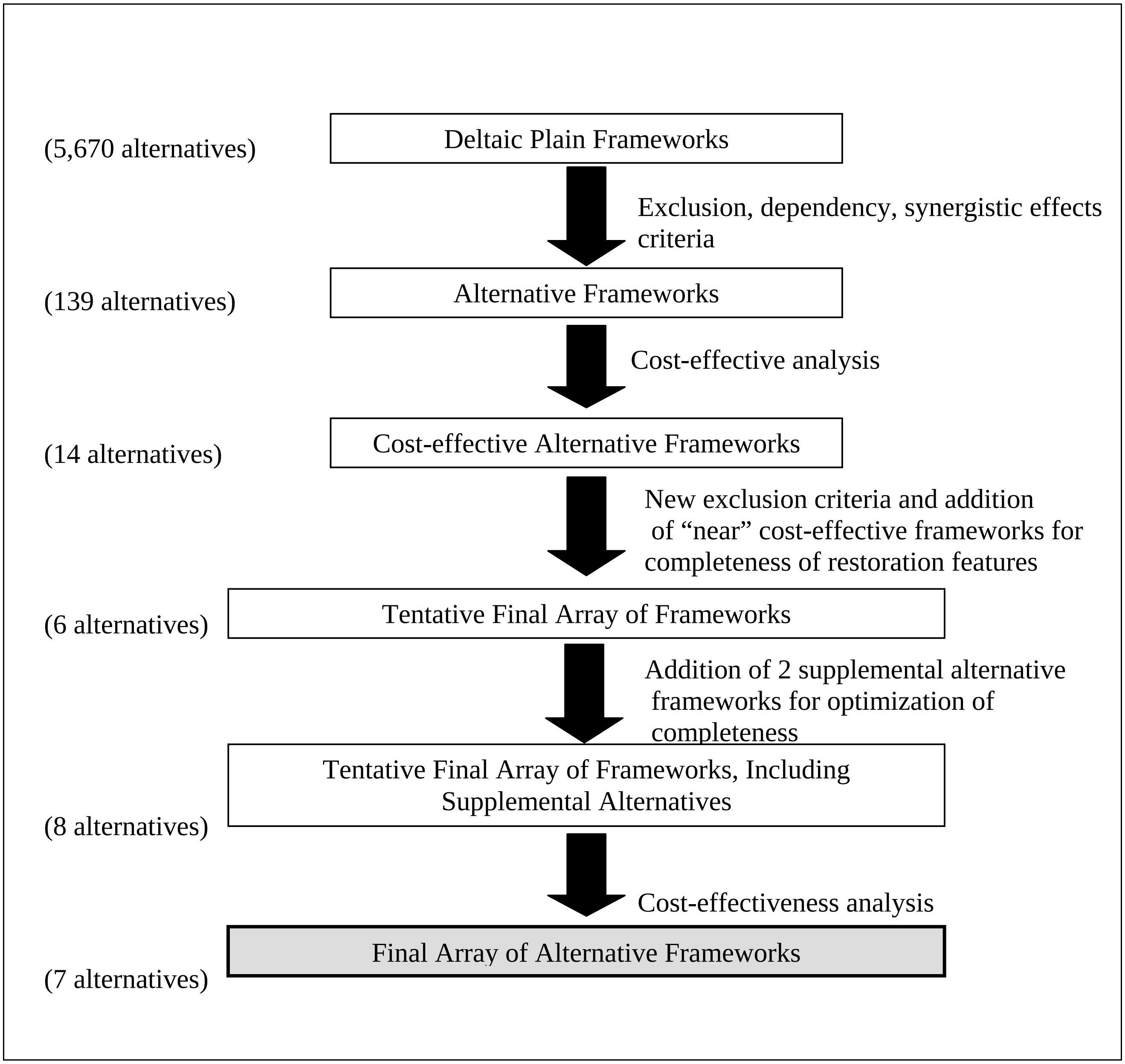


Figure E-23. Cost-Effectiveness and Incremental Cost Analysis Process, Deltaic Plain.

The analysis initially produced 5,670 combinations of alternatives, of which 139 were possibilities after considering exclusions, dependencies, and the water constraints. Of these alternatives, 14 were determined to be cost-effective. The graph below shows the results of the cost-effectiveness analysis (**figure E-24**). All alternative frameworks are shown on the graph, with the cost-effective alternatives (the efficient frontier) highlighted. The small numbers next to each point are framework identifiers used throughout this report. The same identifiers are also used in the accompanying tables.

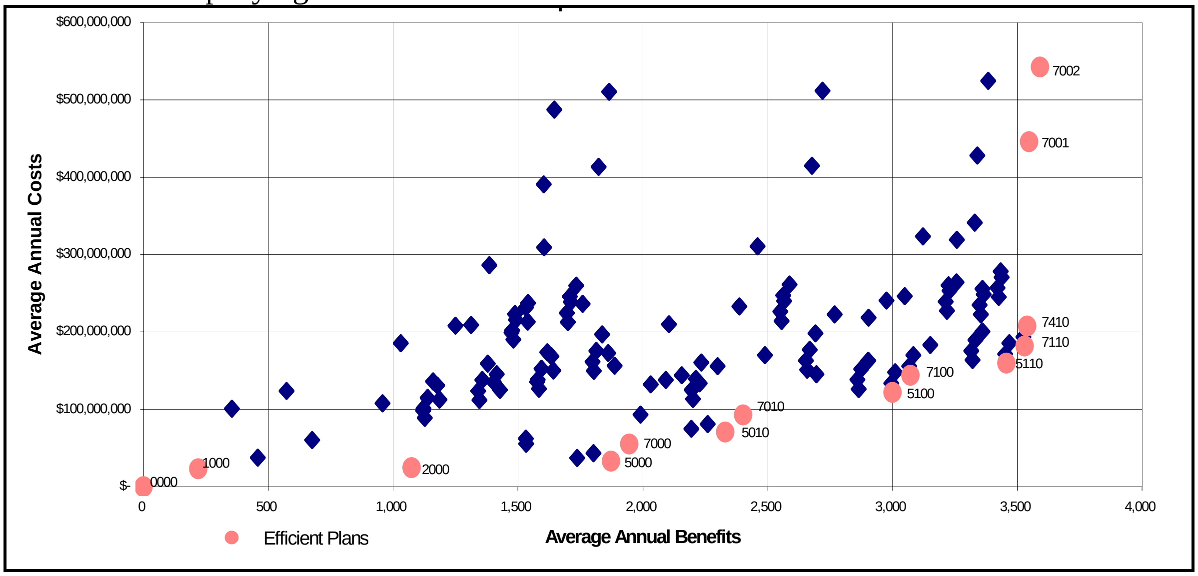


Figure E-24. Average Annual Costs and Average Annual Benefits for Each of the Alternative Frameworks Generated by IWR-Plan for the Deltaic Plain.

The identifiers indicate the alternative associated with Subprovinces 1-3 (**table E-21**). The first digit of the identifier identifies the alternative for Subprovince 1. The second digit identifies the alternative for Subprovince 2. The third digit identifies the alternative for Subprovince 3. Finally, the fourth digit identifies the alternative choice for the Third Delta Project. For example: Framework 7620 would translate to Subprovince 1, E1; Subprovince 2, M3; Subprovince 3, R3; and no Third Delta alternative. Descriptions of each Subprovince alternatives and its corresponding features can be found in Attachment 1. The incremental cost analysis results for the 14 cost-effective alternative frameworks for Subprovinces 1-3 are illustrated in **table E-21**.

Table E-21.
Key to Alternative Framework Identifiers.

Identifier	0	1	2	3	4	5	6	7	8	9	10
Subprovince 1 (First Digit)	NA	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
Subprovince 2 (Second Digit)	NA	R1	R2	R3	M1	M2	M3	E1	E2	N1	
Subprovince 3 (Third Digit)	NA	R1	R3	N1							
Third Delta (Fourth Digit)	NA	SP 2, E3 and SP 3, R2	SP 2, E3 and SP 3, M1								

Where: SP = Subprovince, NA = No Action, R= Reduce, M= Maintain, E= Increase, N = Supplemental

Table E-22.
Costs and Benefits for the Cost-Effective Alternative Frameworks for the Deltaic Plain.

Framework	Average Annual Benefits	Average Annual Costs ($)	Cost per Unit ($)	Incremental Cost
0	0	0	0	0
1000	219	22,910,914	104,616	104,616
2000	1,074	24,350,598	22,673	1,684
5000	1,873	32,838,902	17,533	10,624
7000	1,945	55,021,432	28,289	308,091
5010	2,330	70,438,353	30,231	40,044
7010	2,402	92,620,883	38,560	308,091
5100	3,000	122,043,563	40,681	49,202
7100	3,072	144,226,093	46,949	308,091
5110	3,457	159,643,014	46,180	40,044
7110	3,529	181,825,544	51,523	308,091
7410	3,540	207,599,025	58,644	2,343,044
7001	3,548	445,780,195	125,643	29,772,646
7002	3,591	542,511,742	151,075	2,249,571

* *Benefits measured using the B2 Protocol, as explained in the text. Shaded lines indicate frameworks that were carried forward to the analysis step – the development of a tentative final array of alternatives.*

6.5.8 Development of the Tentative Final Array for the Deltaic Plain

Following an initial CE/ICA analysis, the alternative framework process continued by applying four additional criteria to cost-effective coastwide alternative frameworks. The four criteria are as follows:

1. Alternative frameworks that cost approximately $60 million per year to implement were eliminated from further consideration because the existing CWPPRA was already available for implementing such alternatives. The intent of the LCA effort is to focus on larger-scaled projects that are beyond the current scope of CWPPRA.

2. Alternative frameworks were limited to those that reduced land loss by at least one half of the current rate (based on 1990-2000 landloss data of –24 mi^2/yr to-10 mi^2/yr [-62 km^2/yr to – 26 km^2/yr]).

3. Alternative frameworks were evaluated for their potential to provide storm surge protection across the coast (i.e., in all Subprovinces), as well as for their potential to impact the navigation industry.

4. Alternative frameworks were assessed for their potential to add environmentally significant features, such as barrier islands or a Third Delta feature, in subsequent implementation phases.

During this stage of the alternative framework selection process, the PDT evaluated the alternative frameworks that formed the cost-effective frontier and eliminated several of the frameworks from further consideration. Some cost-effective alternative frameworks were eliminated because they did not provide potential coastwide restoration or economic damage reduction. Other cost-effective alternative frameworks that met these criteria occurred at approximately the point in the cost-effective curve at which the cost per unit benefit begins to rise rapidly. These frameworks were 5110, 7110, and 7410. Framework 7002 represented the terminal point of the cost-effective frontier. Based on the criteria of cost-effectiveness, exceeding minimum program and output values, and providing maximum potential damage reduction, framework 5110 (made up of S1M2, S2R1, and S3R1) would be a rational framework selection. However, upon review of these frameworks, the PDT identified several environmentally significant features that were not included in or addressed by this or any of the cost-effective frameworks.

It was determined that additional alternative frameworks near the cost-effective curve, particularly near the point of rapidly increasing unit cost, could fall within the limits of confidence. In addition, these alternative frameworks would provide more completeness to a final array of restoration solutions. Beginning at the previously identified location on the cost-effective curve, the PDT used the IWR-Plan software and began investigating additional alternative frameworks adjacent to the cost-effective frontier that included significant features not in the cost-effective alternative framework combinations. A number of additional frameworks were identified that addressed the identified significant features such as the barrier islands in Subprovince 3. These included frameworks 5610, 5410, 7610, 5120, 5620, 5710, and 7120. These frameworks were grouped with the remaining 3 cost-effective frameworks to form a tentative final array (**table E-23**). In addition, one cost-effective framework, framework number 7110, appeared to be redundant in its composition but more costly and was not considered by the PDT in the tentative final array.

Table E-23.
Benefits and Costs for Tentative Final Array of Frameworks for the Deltaic Plain.

Framework	Average Annual Benefits	Average Annual Costs ($)	Cost per Unit ($)
5620	3349	234,801,138	70,111
5120	3354	222,964,398	66,477
5710	3361	255,291,778	75,957
7120	3426	319,243,162	93,182
5610	3452	171,479,754	49,675
5110	3457	159,643,014	46,180
5410	3468	185,416,495	53,465
7610	3524	193,662,284	54,955
7410	3540	209,000,000	59,040
7002	3591	542,511,742	151,075

* *Benefits measured using the B2 Protocol, as explained in the text. Shaded lines indicate cost-effective frameworks that were included the tentative final array*.

The following graphs (**figures E-25 and E-26**) illustrate the relationships among the cost-effective frameworks and the additional alternatives in the tentative final array. **Figure E-28** is cropped to depict only the cost-effective and additional alternative frameworks included in the tentative final array. Note that several of the additional frameworks are fairly close to the efficient frontier, and, given the limitations of the benefit data, are within the reasonable limits of confidence for the efficient frontier.

Other frameworks appear to depart from the curve significantly in both cost and benefit. The most notable exception is Framework 7120, which is well above the efficient frontier. While there are also limits in the confidence of the cost data, these limits are not as significant as they are for the benefit data. As a result, these frameworks were determined to be significantly more costly per habitat unit produced in comparison to the other alternatives available that provided the same restoration benefit. Thus, frameworks 5120, 5620, 5710, and 7120 were dropped from further consideration.

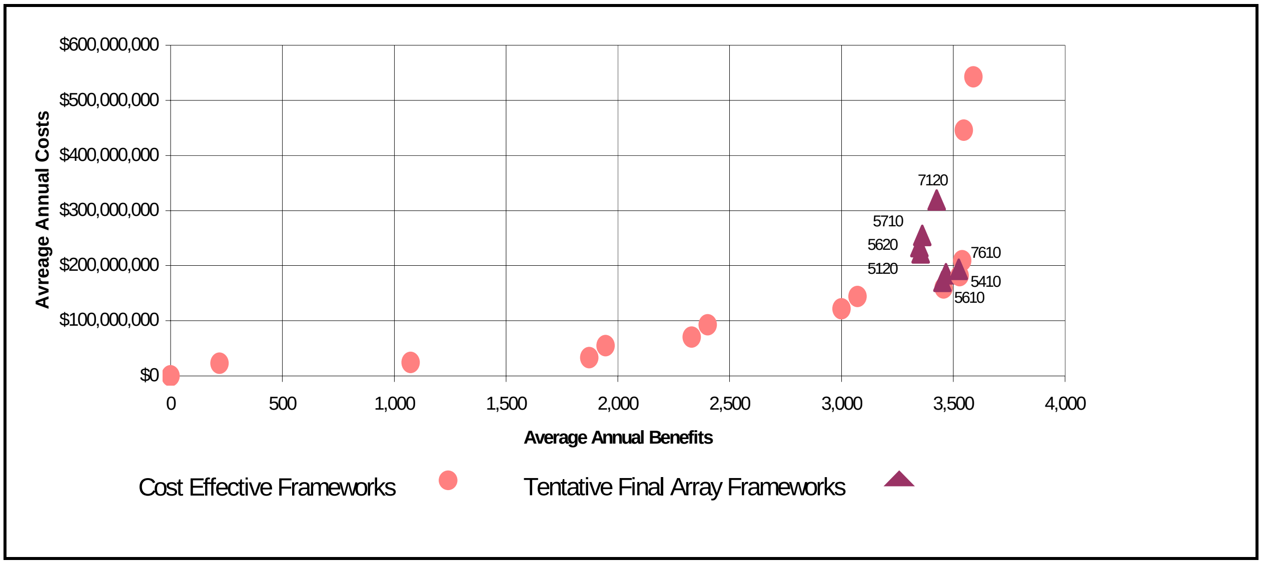


Figure E-25. Costs and Benefits for the Cost-Effective and Tentative Final Array of Frameworks for the Deltaic Plain.

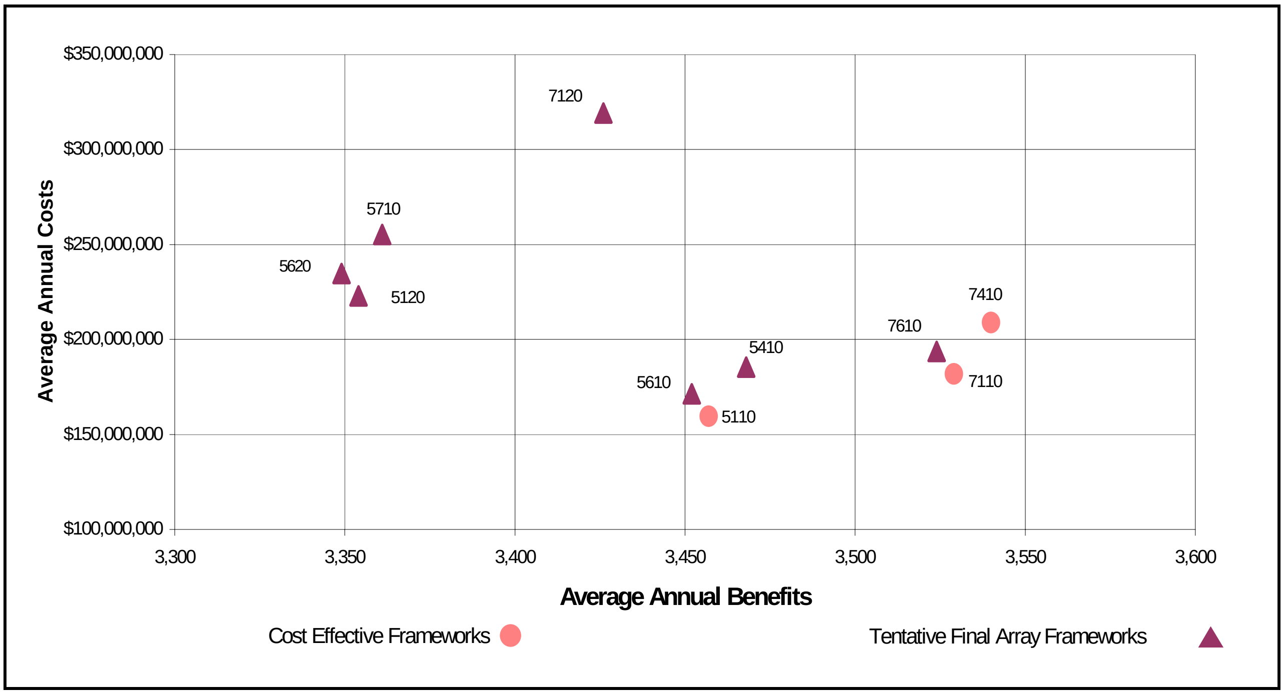


Figure E-26. Costs and Benefits for the Tentative Final Array of Frameworks of Interest for the Deltaic Plain (expanded view).

6.5.9 Development of Supplemental Frameworks to Address Completeness of Final Array

The executive team, vertical team, and individual members of the framework development team, reviewed the cost-effectiveness analysis and the PDT effort in developing the tentative final array. Following this review, the executive team directed the PDT to develop two supplemental frameworks to attempt to further address the criteria of environmentally significant features. These frameworks were also intended to address the completeness of the final array since the tentative frameworks identified by the initial analysis omitted a number of larger-scale features that were viewed as potentially critical to long-range success. The output from the ecological modeling and the experience gained from that effort provided valuable insight regarding framework effectiveness. The results of that effort were reviewed to determine what specific restoration features might be introduced to create a more complete and effective alternative framework.

The PDT reviewed the features, model outputs, and framework components for each subprovince. At the conclusion of this effort, the PDT had assembled the two supplemental alternative frameworks, which were loosely based on the alternative framework 5610. These two supplemental alternative frameworks were identical, except that one of the frameworks contained the Third Delta feature. Once the features of the supplemental alternative frameworks were identified, costs and benefits were developed for the supplemental alternatives in a manner consistent with the previously analyzed alternative frameworks (**table E-24**). These data were incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the two supplemental alternative frameworks relative to the cost-effective frontier.

Table E-24.
Benefits and Costs for Tentative Final Array with Supplemental Frameworks for the Deltaic Plain.

Framework	Average Annual Benefits	Average Annual Costs ($)	Cost per Unit ($)
5610	3,452	171,479,754	49,675
5110	3,457	159,643,014	46,180
5410	3,468	185,416,495	53,465
7610	3,524	193,662,284	54,955
7410	3,540	209,000,000	59,040
7002	3,591	542,511,742	151,075
A1	2,797	196,257,904	70,167
A2	3,321	405,580,519	122,126

* *Benefits measured using the B2 Protocol, as explained in the text. Shaded lines indicate cost-effective frameworks that were included the tentative final array*.

This analysis revealed that the basic supplemental framework was significantly above and to the left of the efficient frontier. The second supplemental framework was developed by simply combining the Third Delta feature with the basic supplemental framework. Neither framework plotted within the optimal range of the existing final array of alternative frameworks (**figure E-27**). A review of the features included in the second supplemental framework revealed that several of the diversion features could be redundant and potentially unimplementable with the inclusion of the Third Delta. Framework 7002 included several of the features identified for detailed investigation in the basic supplemental and include it as the supplemental framework along with framework 7002 in the final array.

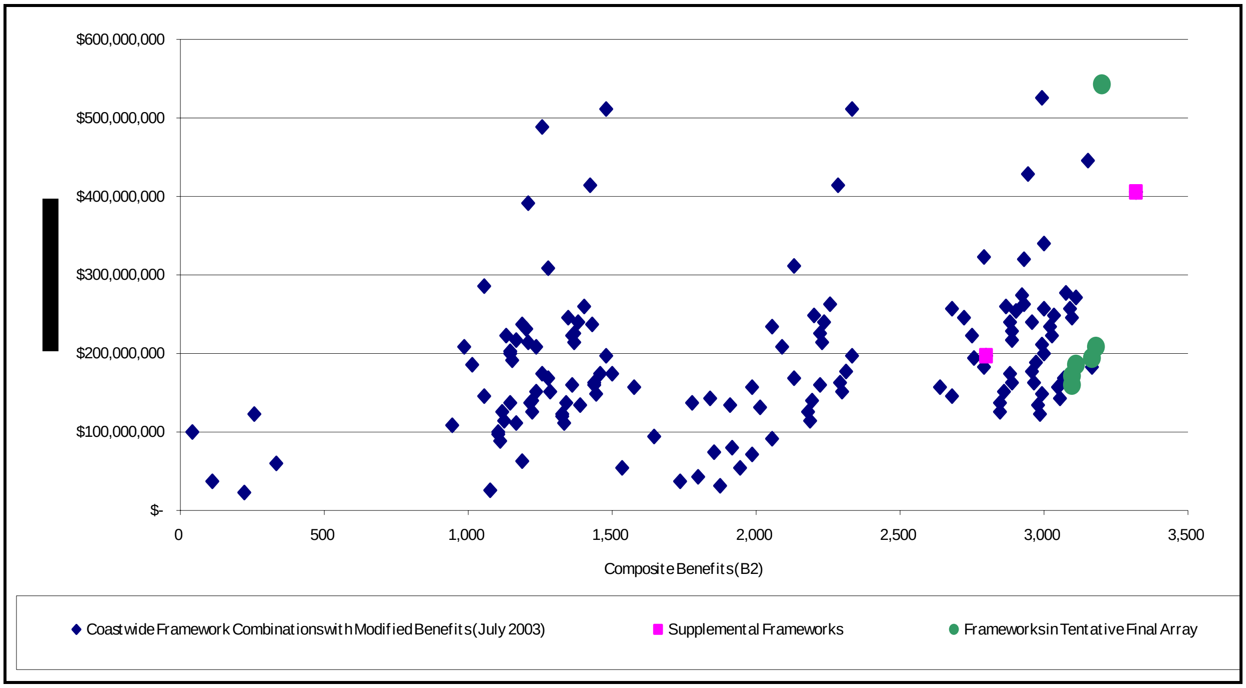


Figure E-27. Comparison of Supplemental Alternative Frameworks for the Deltaic Plain.

To further determine whether the combinable components of the supplemental framework had any specific strengths or weaknesses, another iteration of cost-effectiveness was executed for each subprovince. This analysis identified the strength (high B2 benefit value) of the supplemental framework in Subprovince 1 and its weakness (low B2 benefit value) in Subprovince 2. The supplemental alternative framework features were similar to existing components in Subprovinces 3 and 4. The results for Subprovince 4 are presented later in this section. Presented below is the relative efficiency of the supplemental framework components for each of Subprovinces 1, 2, and 3 (**figures E-28, E-29 and E-30**). The supplemental alternative framework features are labeled as N1 in each plot.

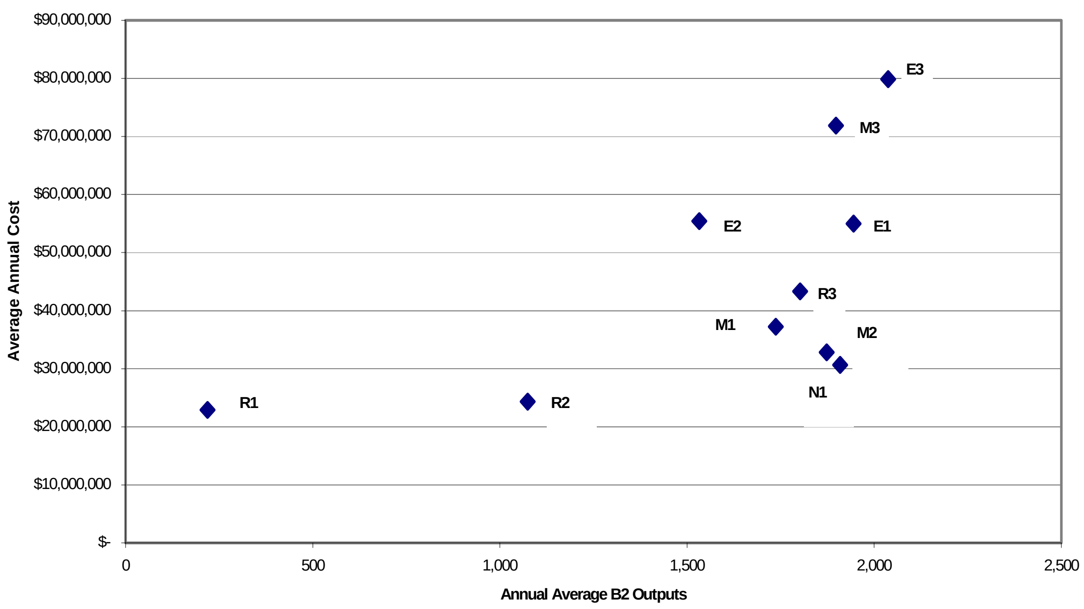


Figure E-28. Cost Effectiveness Graph of the Subprovince 1 Alternative Frameworks with Supplemental Framework (A-1).

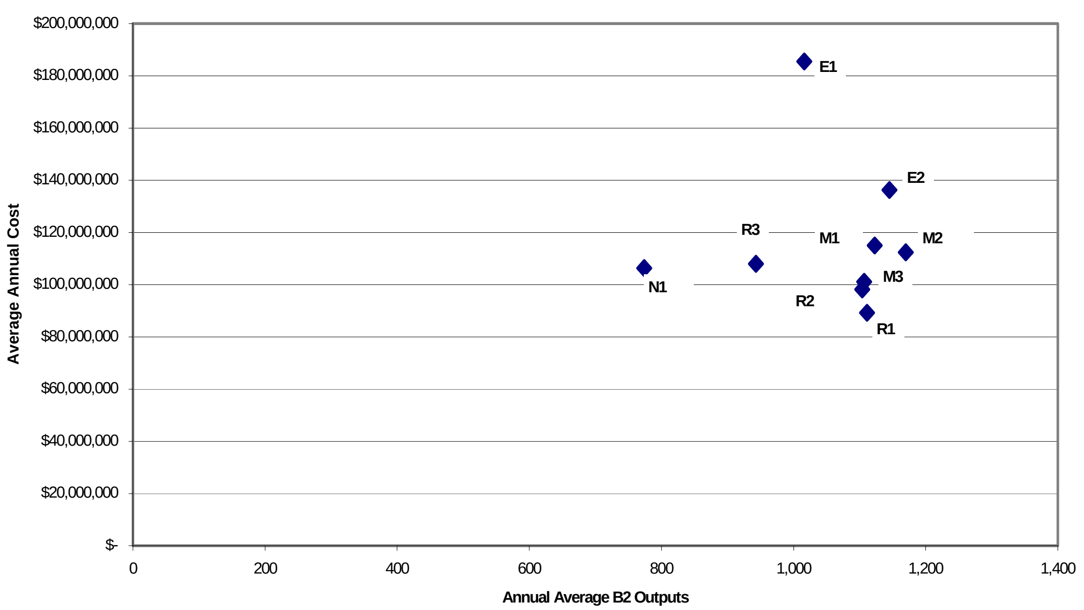


Figure E-29. Cost Effectiveness Graph of the Subprovince 2 Alternative Frameworks with Supplemental Framework (A-1).

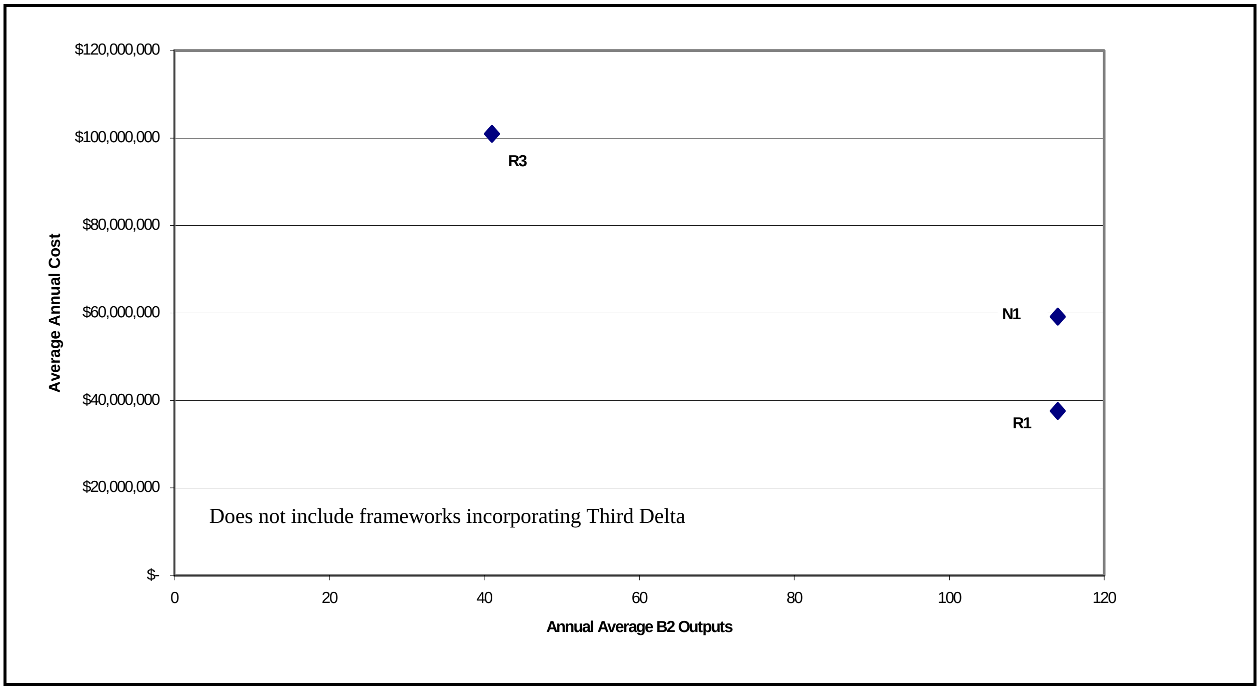


Figure E-30. Cost Effectiveness Graph of the Subprovince 3 Alternative Frameworks with Supplemental Framework (A-1).

The study executive team reviewed this information and was able to identify an existing alternative in Subprovince 2 that in combination with the other supplemental framework components in Subprovinces 1 and 3 could produce a modified supplemental framework that would enhance completeness and be cost-effective. The data for the modified supplemental framework, which was labeled 10130 (based on the IWR-Plan system of numbering solution scales), was added to the IWR-Plan database. An additional iteration of the cost-effectiveness analysis revealed the supplemental framework to be on the cost-effective curve and consistent with the position and criteria for the final array. The output for the final iteration of the CE/ICA is discussed below.

6.5.10 <u>Final Iteration Results for the Deltaic Plain</u>

All iterations of the analysis were performed in a manner consistent with the description of the initial cost-effectiveness analysis. Once again, the benefit units used for the analysis are described by the B2 protocol.

The analysis initially produced 25,920 combinations of frameworks, 152 of which were possible after considering exclusions, dependencies, and the total diversion constraint. It can be observed by comparing the initial and final analyses that the addition of even a small number of solutions or scales has an exponential effect on the number of possible combinations. Of these frameworks, 15 were determined to be cost-effective. The graph below (**figure E-31**) shows the results of the cost-effectiveness analysis. All 152 possible frameworks are shown on the graph, with the cost-effective frameworks (the efficient frontier) highlighted.

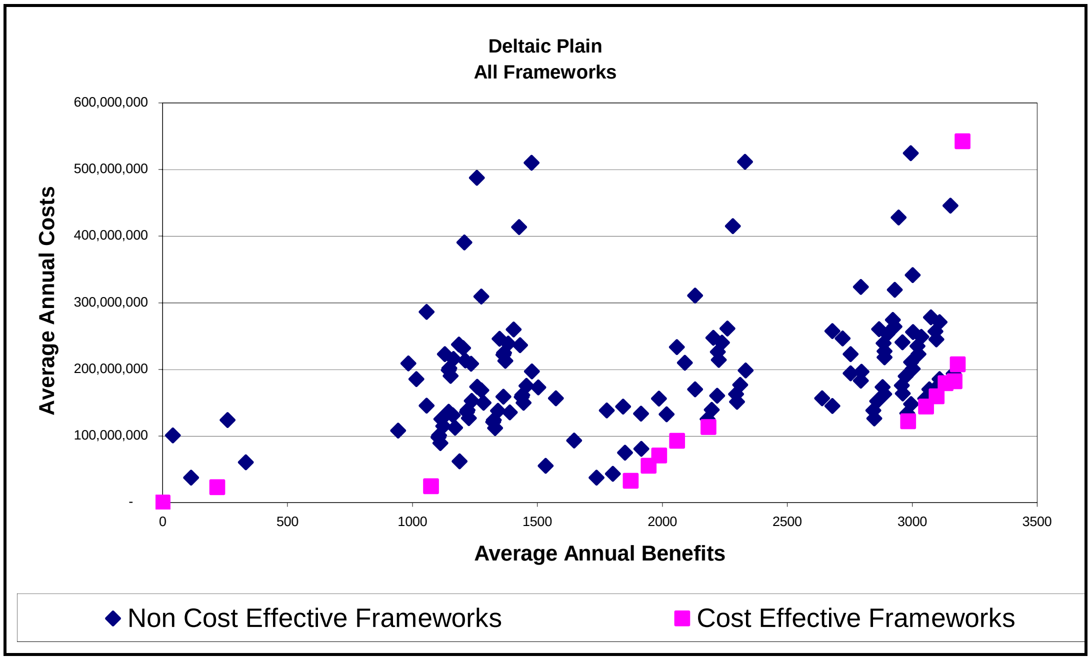


Figure E-31. Average Annual Costs and Average Annual Benefits for all Frameworks in the Cost-Effectiveness Analysis.

The incremental cost analysis results for the Deltaic Plain are illustrated in **table E-25** in ascending order of benefit performance. Only the cost effective frameworks are included in the table. The numbers in the first column of the table are codes for each framework that were generated by the program that was used to conduct the analysis. These identifiers are used throughout the report, and are placed next to the points used to represent each framework in the subsequent graphs. The second column shows a shorthand description of each framework. The number appearing after each "S" is the subprovince number. Alternatives designed to maintain the quantity or quality of habitat are labeled with an "M"; alternatives designed to increase habitat are labeled with an "E." Some frameworks are designed to preserve or increase habitat in the future at a level higher than in the future without-project condition, but at some level below existing conditions. These "reduced" alternatives are labeled "R." As an example, in row 3, Framework 2000 (S1R2) calls for Reduce Alternative 2 in Subprovince 1. The final array of alternatives, including the modified supplemental framework, is shown in the **table E-26**.

Table E-25.
Benefits and Costs for the Cost Effective Alternative Frameworks, Including Supplemental Alternative Frameworks for the Deltaic Plain.

Framework Code	Framework Components	Average Annual Benefits 1/	Incremental Benefits 2/	Average Annual Costs 3/ ($)	Incremental Costs 4/ ($)	Incremental Cost per Unit 5/ ($)	Ave. Annual Cost/Ave. Annual Benefit ($)
0000	No Action	0		-		-	-
1000	S1R1	219	219	22,911,000	22,911,000	104,616	104,616
2000	S1R2	1074	855	24,351,000	1,440,000	1,684	22,673
5000	S1M2	1873	799	32,839,000	8,488,000	10,623	17,533
7000	S1E1	1945	72	55,021,000	22,182,000	308,083	28,288
5010	S1M2, S3R1	1987	42	70,438,000	15,417,000	367,071	35,449
7010	S1E1, S3R1	2059	72	92,621,000	22,183,000	308,097	44,983
2100	S1R2, S2R1	2185	126	113,555,000	20,934,000	166,143	51,970
5100	S1M2, S2R1	2984	799	122,044,000	8,489,000	10,625	40,899
7100	S1E1, S2R1	3056	72	144,226,000	22,182,000	308,083	47,194
5110	S1M2, S2R1, S3R1	3098	42	159,643,000	15,417,000	367,071	51,531
10130	S1N1, S2N1, S3N1	3134	36	179,074,000	19,431,000	539,750	57,139
7110	S1E1, S2R1, S3R1	3170	36	181,826,000	2,752,000	76,444	57,358
7410	S1E1, S2M1, S3R1	3182	12	207,599,000	25,773,000	2,147,750	65,242
7002	S1E1, S2E3, S3M1	3202	20	542,512,000	334,913,000	16,745,650	169,429

1/ Benefits featured using the B2 Protocol, as explained in the text.
2/ Incremental benefits are the benefits of each framework less the benefits of the framework with the next lower cost.
3/ Average annual costs are the implementation costs annualized over 50 years.
4/ Incremental costs are the costs of each framework less the costs of the next lower cost framework.
5/ Incremental costs per unit are the incremental costs divided by the incremental units of output provided by each framework. Shaded lines indicate frameworks that were carried forward to the final array.

Table E-26.
The Final Array of Frameworks for the Deltaic Plain,
Including Supplemental Alternative Frameworks.

Framework Code	Framework Components	Average Annual Benefits [1/]	Incremental Benefits [2/]	Average Annual Costs [3/] ($)	Incremental Costs [4/] ($)	Incremental Cost per Unit [5/] ($)	Ave. Annual Cost/Ave. Annual Benefit ($)
0000	No Action	0		-		-	-
5610	S1M2, S2M3, S3R1	3094	3094	171,480,000	171,480,000	55,423	55,423
5110	S1M2, S2R1, S3R1	3098	4	159,643,000	(11,837,000)	(2,959,250)	51,531
5410	S1M2, S2M1, S3R1	3110	12	185,416,000	25,773,000	2,147,750	59,619
10130	S1N1, S2N1, S3N1	3134	24	179,074,000	(6,342,000)	(264,250)	57,139
7610	S1E1, S2M3, S3R1	3166	32	193,662,000	14,588,000	455,875	61,169
7410	S1E1, S2M1, S3R1	3182	16	207,599,000	13,937,000	871,063	65,242
7002	S1E1, S2E3, S3M1	3202	20	542,512,000	334,913,000	16,745,650	169,429

1/ Benefits featured using the B2 Protocol, as explained in the text.
2/ Incremental benefits are the benefits of each framework less the benefits of the framework with the next lower cost.
3/ Average annual costs are the implementation costs annualized over 50 years.
4/ Incremental costs are the costs of each framework less the costs of the next lower cost framework.
5/ Incremental costs per unit are the incremental costs divided by the incremental units of output provided by each framework. Shaded lines indicate frameworks that were carried forward to the final array.

The following graph (**figure E-32**) illustrates the relationships of the final array of coastwide alternative frameworks to all other frameworks considered. The graph depicts only the cost-effective and supplemental alternative frameworks that are discussed in detail in the main report section on framework formulation. The results of the final iteration of cost-effectiveness illustrated that the alternative frameworks identified in the tentative final array remained consistent in their position relative to the efficient frontier. The inclusion of the supplemental alternative framework (10130) in this iteration of the analysis resulted in the addition of this alternative framework to the efficient frontier.

The alternative frameworks are all fairly close to the efficient frontier, and, given limitations of both the benefit and cost data, are within the margin of error for the efficient frontier. That is, given the level of accuracy in the model's prediction of benefits and limitations on our ability to estimate costs, it is not possible to state with certainty that the supplemental alternative framework that was considered is less efficient than those on the efficient frontier. The exception, since the framework that produces the maximum possible output is always a component of the efficient frontier, is framework 7002. This framework has costs far in excess of frameworks which produce only slightly lower benefit levels, as illustrated in the graph below.

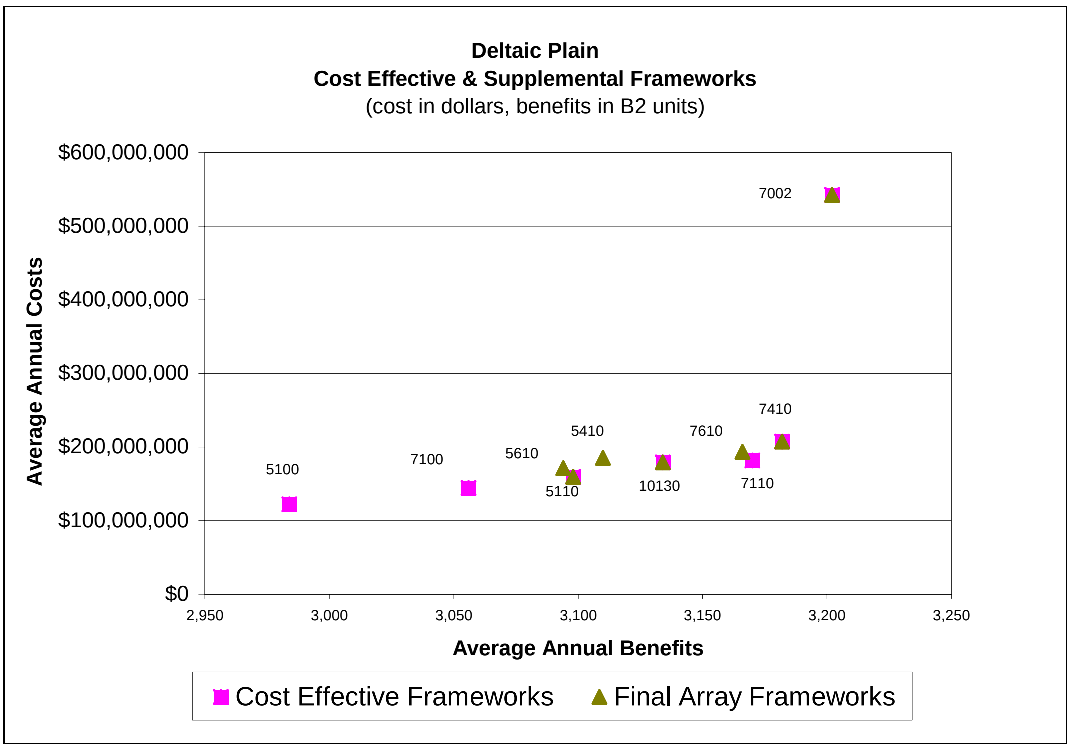


Figure E-32. Average Annual Costs and Average Annual Benefits for the Final Array of Frameworks for the Deltaic Plain.

The bar graph below also illustrates the relationships of benefits and costs for the array of frameworks (**figure E-33**). Benefits are expressed in average annual benefit units (B2), while average annual costs are shown in hundreds of thousands of dollars. The graph indicates that the level of benefits does not greatly vary for the array of alternative frameworks. As previously stated, this is especially important to note given the level of accuracy associated with the model (as discussed elsewhere in the report).

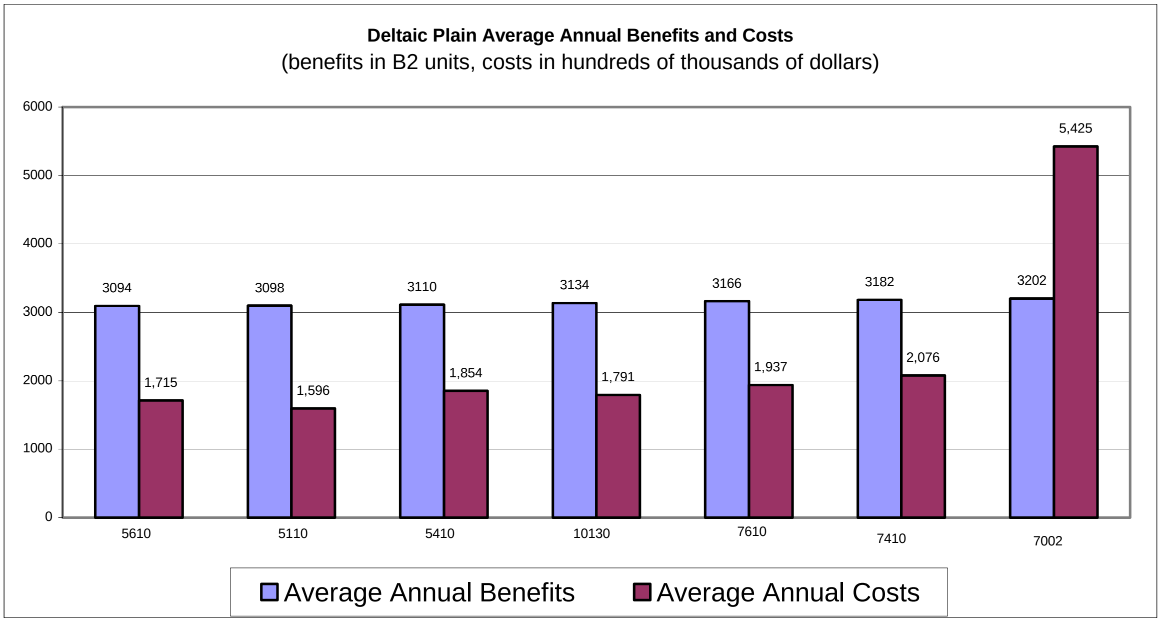


Figure E-33. Chart of Average Annual Benefits and Average Annual Costs for the Cost Effective Frameworks in the Deltaic Plain.

6.5.11 Development of the Final Array for the Chenier Plain

Habitats in the Chenier Plain were created by processes that did not include periodic overflows of the river to build and maintain land. Accordingly, frameworks for Subprovince 4 that create and preserve habitat are not constrained by the amount of water and sediment available in the Mississippi River. Consequently, the PDT evaluated Subprovince 4 separately from the other three subprovinces, which comprised the Deltaic Plain.

Because there is no nitrogen removal issue in the Chenier Plain and the habitat created in this area is expected to be fairly uniform in quality, evaluation of Subprovince 4 frameworks was solely based on land creation. Any of the outcomes here could be combined with any of the seven frameworks in the final array for the Deltaic Plain.

The cost-effective analysis produced a cost-effective curve consisting of only one cost-effective framework, M3. The PDT reviewed the cost-effectiveness analysis results and recognized that framework M3 failed to significantly address the core restoration strategy for the Chenier Plain of controlling estuarine salinities. In addition, the PDT suggested that the "Increase" planning scale be adopted as the minimum restoration level in this subprovince due to the relatively low rate of loss.

6.5.12 Development of framework of Final Array for the Chenier Plain

The executive team, as well as the vertical team and members of the framework development team, again reviewed the cost-effectiveness analysis and the PDT effort in identifying the cost-effective frameworks for the Chenier Plain. The executive team directed the PDT to develop a supplemental framework to better address the core strategy. While not cost-effective, the relative ability of framework E2 to better address the core restoration strategy (i.e., salinity control) was suggested as a starting point to develop the supplemental framework. During a 2-day meeting of the executive team and PDT, the PDT assembled the supplemental framework, which was based on the framework E2. The criteria concerning the identification and inclusion of any environmentally significant features applied in the Deltaic Plain also applied to this subprovince.

Once the features of the supplemental alternative framework were identified, costs and benefits were developed for the framework in a manner consistent with the previously analyzed alternative frameworks. This data was incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the supplemental alternative framework relative to the efficient frontier. Once again, the supplemental framework was intended to add to the completeness of the final array.

Eight subprovince frameworks, including the supplemental framework and the No Action Alternative, were evaluated for the Chenier Plain (**figure E-34**). As stated previously, the Chenier Plain was analyzed separately and thus frameworks that are not combinable were analyzed independently.

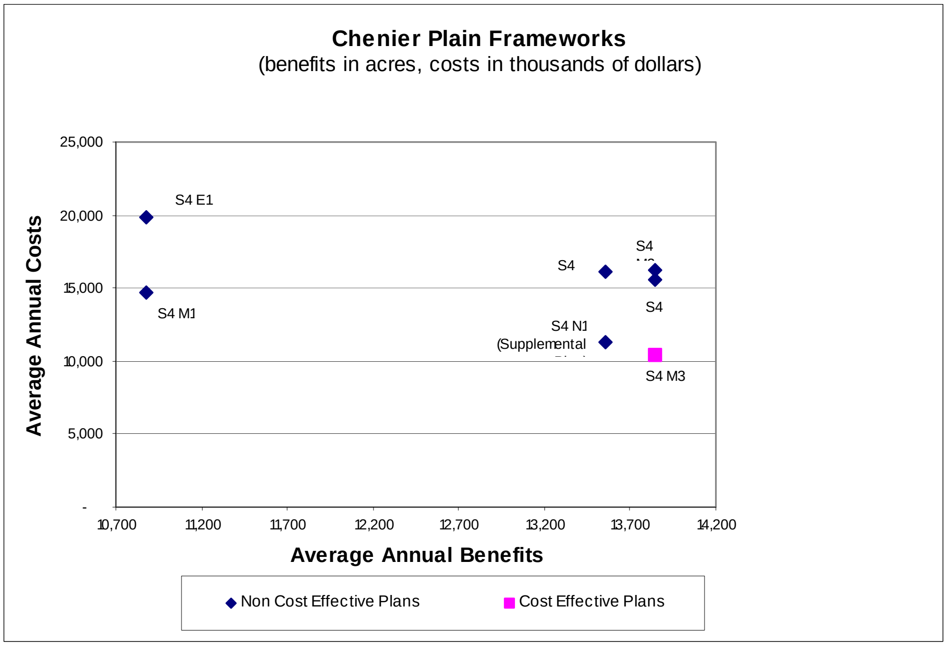


Figure E-34. Costs and Benefits (acres) for all Chenier Plain Frameworks.

A second iteration once again resulted in the identification of only one cost-effective framework, M3. However, the added supplemental framework (N1) was similar in average annual cost but produced slightly fewer average annual benefits. The features in framework M3 failed to significantly address the core restoration strategy for Subprovince 4, as previously identified by the PDT. Framework N1 included the major features of framework M3 in addition to features to address salinity control. As a result, framework M3 was dropped from the final array. The final array focuses on framework N1, the supplemental framework that was developed by modifying framework E2.

6.5.13 Details of the Final Array of Coast wide System Frameworks

As stated previously, the Chenier Plain framework can be added to any of the seven Deltaic Plain frameworks to construct coast wide frameworks, resulting in seven coast wide frameworks. **Table E-27** identifies the subprovince framework components of each of the system frameworks identified in the final array. The subprovince frameworks considered, and the features included in them, can be found in **tables E-3** through **E-6.** The final array of coast wide system frameworks identified a relatively tight grouping of possible alternatives. In comparing these alternatives, the PDT observed numerous cases of common features between the frameworks. The differences in restoration features between the frameworks, however, typically resulted in an observable difference in the make up of their beneficial outputs (i.e., the balance of marsh type and resultant species usage). The end result was that any of the frameworks in the final array could be a justifiable plan depending on the nuances applied in developing a single output value for their comparison.

In addition, the PDT recognized that the relative uncertainty of quantifying ecologic performance and sustainability versus the somewhat more certain quantification of implementation cost caused a variable effect on certainty across the range of features considered in the system wide frameworks. Particularly, larger-scale, longer range restoration features compared poorly in a comparative analysis. As a result, for the longer-range features included in the various frameworks, there were lower confidence limits that have implications for the overall timing of their implementation. Conversely, features that could be implemented and produce environmental outputs in the near-term resulted in a higher degree of confidence.

Table E-27. Overview of Final Array of Coast wide Restoration Frameworks.

	Framework Identification						
	5110	5610	5410	7610	7410	7002	10130
Subprovince 1							
M2	**X**	**X**	**X**				
E1				**X**	**X**	**X**	
N1 (Modified M2)							**X**
Subprovince 2							
R1	**X**						
M1			**X**		**X**		
M3		**X**		**X**			
E3						**X**	
N1 (Modified R1)							**X**
Subprovince 3							
R1	**X**	**X**	**X**	**X**	**X**		
M1						**X**	
N1 (Modified R1)							**X**
Subprovince 4							
N1 (Modified E2)	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Of the 111 features, 79 features are contained in the final array of coast wide frameworks identified in **table E-27**. Descriptions of the 79 features are found in section 3.3.6.1.

A listing of these framework components detailing the features included in each one is presented in **table E-28**. Additional details on all of the subprovince frameworks considered, and the features included within those frameworks, as well as those included in the final array, can be found Attachment 1.

Table E-28.
Final Array of Frameworks Details.

Framework 5110

Subprovince 1, M2 (Continuous Reintroduction)

- 5,000 cfs diversion at Convent/Blind River
- 1,000 cfs diversion at Hope Canal
- 10,000 cfs diversion at White's Ditch
- 110,000 cfs diversion at American/California Bay with sediment enrichment
- 12,000 cfs diversion at Bayou Lamoque
- ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

Subprovince 2, R1 (Minimize Salinity Changes)

- 5,000 cfs diversion @ Edgard w/sediment enrichment
- Sediment delivery via pipeline at Myrtle Grove
- 5,000 cfs diversion at Myrtle Grove
- Marsh creation @ Wetland Creation and Restoration feasibility study sites
- Barrier Island restoration @ Barataria Shoreline (3000')
- 60,000 cfs diversion @ Fort Jackson

Subprovince 3, R1 (Maximize Atchafalaya Flow)

- Bayou Lafourche 1,000 cfs pump
- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Freshwater introduction south of Lake Decade
- Penchant Basin Framework
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet
- Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
- Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
- ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
- Multi-purpose operation of the Houma Navigation Canal Lock
- Maintain land bridge between Bayous Dularge and Grand Caillou

Subprovince 4, E2 (Perimeter Structure Salinity Control):

- Gulf Shoreline Stabilization
- Calcasieu Ship Channel beneficial use
- Dedicated dredging for marsh restoration

Calcasieu Subbasin Perimeter Plan

- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Salinity control at Alkali Ditch
- New Lock at Gulf Intracoastal Waterway
- Modify existing Cameron-Creole Watershed control structures

Sabine Subbasin Perimeter Plan

- East Sabine Lake Hydrologic Restoration
- Salinity control at Black Bayou
- Salinity control at Highway 82 causeway

Mermentau Basin Freshwater Introduction

- Freshwater introduction at Pecan Island
- Freshwater introduction at Rollover Bayou
- Freshwater introduction at Highway 82
- Freshwater introduction at Little Pecan Bayou
- Freshwater introduction at South Grand Chenier

Framework 5110 (continued)

Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 5610

Subprovince 1, M2 (Continuous Reintroduction)
• 5,000 cfs diversion at Convent/Blind River • 1,000 cfs diversion at Hope Canal • 10,000 cfs diversion at White's Ditch • 110,000 cfs diversion at American/California Bay with sediment enrichment • 12,000 cfs diversion at Bayou Lamoque ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
Subprovince 2, M3 (Mimic Historic Hydrology)
• 1,000 cfs diversion @ Lac des Allemands • 1,000 cfs diversion @ Donaldsonville • 1,000 cfs diversion @ Pikes Peak • 1,000 cfs diversion @ Edgard • 75,000 cfs diversion @ Myrtle Grove w/sediment enrichment • 60,000 cfs diversion @ Fort Jackson with sediment enrichment • Barrier Island Restoration @Barataria Shoreline (3,000')
Subprovince 3, R1 (Maximize Atchafalaya Flow)
• Bayou Lafourche 1,000 cfs pump • Convey Atchafalaya River water to Terrebonne marshes • Freshwater introduction via Blue Hammock Bayou • Freshwater introduction south of Lake Decade • Penchant Basin Framework • Relocate the Atchafalaya navigation channel • Increase sediment transport down Wax Lake Outlet • Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island • Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands • Multi-purpose operation of the Houma Navigation Canal Lock • Maintain land bridge between Bayous Dularge and Grand Caillou
Subprovince 4, E2 (Perimeter Structure Salinity Control)
• Gulf Shoreline Stabilization • Calcasieu Ship Channel beneficial use • Dedicated dredging for marsh restoration **Calcasieu Subbasin Perimeter Framework** • Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • New Lock at Gulf Intracoastal Waterway • Modify existing Cameron-Creole Watershed control structures **Sabine Subbasin Perimeter Framework** • East Sabine Lake Hydrologic Restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway **Mermentau Basin Freshwater Introduction** • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier

Framework 5610 (continued)

Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 5410

Subprovince 1, M2 (Continuous Reintroduction)

- 5,000 cfs diversion at Convent/Blind River
- 1,000 cfs diversion at Hope Canal
- 10,000 cfs diversion at White's Ditch
- 110,000 cfs diversion at American/California Bay with sediment enrichment
- 12,000 cfs diversion at Bayou Lamoque
- ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

Subprovince 2, M1 (Minimize Salinity Changes)

- 5,000 cfs diversion @ Lac des Allemands with sediment enrichment
- Sediment delivery via pipeline @ Myrtle Grove
- 5,000 cfs diversion @ Myrtle Grove
- Barrier Island Restoration @Barataria Shoreline (3,000')
- 60,000 cfs diversion @ Fort Jackson
- Sediment delivery via pipeline @ Empire
- Sediment delivery via pipeline @ Bastion Bay
- Sediment delivery via pipeline @ Main Pass (Head of Passes)
- Marsh creation @ Wetland Creation and Restoration feasibility study sites

Subprovince 3, R1 (Maximize Atchafalaya Flow)

- Bayou Lafourche 1,000 cfs pump
- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Freshwater introduction south of Lake De Cade
- Penchant Basin Framework
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet
- Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
- Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
- ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
- Multi-purpose operation of the Houma Navigation Canal Lock
- Maintain land bridge between Bayous Dularge and Grand Caillou

Subprovince 4, E2 (Perimeter Structure Salinity Control)

- Gulf Shoreline Stabilization
- Calcasieu Ship Channel beneficial use
- Dedicated dredging for marsh restoration

Calcasieu Subbasin Perimeter Plan

- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Salinity control at Alkali Ditch
- New Lock at Gulf Intracoastal Waterway
- Modify existing Cameron-Creole Watershed control structures

Sabine Subbasin Perimeter Plan

- East Sabine Lake Hydrologic Restoration
- Salinity control at Black Bayou
- Salinity control at Highway 82 causeway

Mermentau Basin Freshwater Introduction

- Freshwater introduction at Pecan Island
- Freshwater introduction at Rollover Bayou
- Freshwater introduction at Highway 82
- Freshwater introduction at Little Pecan Bayou
- Freshwater introduction at South Grand Chenier

Framework 5410 (continued)

Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7610

Subprovince 1, E1 (Minimize Salinity Changes)
• 5,000 cfs diversion at Convent / Blind River
• 10,000 cfs diversion at Bonnet Carre Spillway
• Sediment delivery via pipeline at Labranche Wetlands
• Sediment delivery via pipeline at Golden Triangle Area
• Sediment delivery via pipeline at Central Wetlands
• 6,000 cfs diversion at White's Ditch
• Sediment delivery via pipeline at American / California Bay
• Sediment delivery via pipeline at Quarantine Bay
• Sediment delivery via pipeline at Fort St. Philip
• 15,000 cfs diversion at American / California Bay
• 15,000 cfs diversion at Fort St. Philip
◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
Subprovince 2, M3 (Mimic Historic Hydrology)
• 1,000 cfs diversion @ Lac des Allemands
• 1,000 cfs diversion @ Donaldsonville
• 1,000 cfs diversion @ Pikes Peak
• 1,000 cfs diversion @ Edgard
• 75,000 cfs diversion @ Myrtle Grove with sediment enrichment
• 60,000 cfs diversion @ Fort Jackson with sediment enrichment
• Barrier Island Restoration @Barataria Shoreline (3,000')
Subprovince 3, R1 (Maximize Atchafalaya Flow)
• Bayou Lafourche 1,000 cfs pump
• Convey Atchafalaya River water to Terrebonne marshes
• Freshwater introduction via Blue Hammock Bayou
• Freshwater introduction south of Lake Decade
• Penchant Basin Plan
• Relocate the Atchafalaya navigation channel
• Increase sediment transport down Wax Lake Outlet
• Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
• Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
• Multi-purpose operation of the Houma Navigation Canal Lock
• Construct a land bridge between Bayous Dularge and Grand Caillou
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7610 (continued)

Subprovince 4, E2 (Perimeter Structure Salinity Control)
• Gulf Shoreline Stabilization • Calcasieu Ship Channel beneficial use • Dedicated dredging for marsh restoration **Calcasieu Subbasin Perimeter Plan** • Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • New Lock at Gulf Intracoastal Waterway • Modify existing Cameron-Creole Watershed control structures **Sabine Subbasin Perimeter Plan** • East Sabine Lake Hydrologic Restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway **Mermentau Basin Freshwater Introduction** • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7410

Subprovince 1, E1 (Minimize Salinity Changes)
• 5,000 cfs diversion at Convent / Blind River • 10,000 cfs diversion at Bonnet Carre Spillway • Sediment delivery via pipeline at Labranche Wetlands • Sediment delivery via pipeline at Golden Triangle Area • Sediment delivery via pipeline at Central Wetlands • 6,000 cfs diversion at White’s Ditch • Sediment delivery via pipeline at American / California Bay • Sediment delivery via pipeline at Quarantine Bay • Sediment delivery via pipeline at Fort St. Philip • 15,000 cfs diversion at American / California Bay • 15,000 cfs diversion at Fort St. Philip ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
Subprovince 2, M1 (Minimize Salinity Changes)
• 5,000 cfs diversion @ Lac des Allemands with sediment enrichment • Sediment delivery via pipeline @ Myrtle Grove • 5,000 cfs diversion @ Myrtle Grove • Barrier Island Restoration @Barataria Shoreline (3,000') • 60,000 cfs diversion @ Fort Jackson • Sediment delivery via pipeline @ Empire • Sediment delivery via pipeline @ Bastion Bay • Sediment delivery via pipeline @ Main Pass (Head of Passes) • Marsh creation @ Wetland Creation and Restoration feasibility study sites
Subprovince 3, R1 (Maximize Atchafalaya Flow)
• Bayou Lafourche 1,000 cfs pump • Convey Atchafalaya River water to Terrebonne marshes • Freshwater introduction via Blue Hammock Bayou • Freshwater introduction south of Lake Decade • Penchant Basin Plan • Relocate the Atchafalaya navigation channel • Increase sediment transport down Wax Lake Outlet • Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island • Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands • Multi-purpose operation of the Houma Navigation Canal Lock • Maintain land bridge between Bayous Dularge and Grand Caillou

◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7410 (continued)

Subprovince 4, E2 (Perimeter Structure Salinity Control)

- Gulf Shoreline Stabilization
- Calcasieu Ship Channel beneficial use
- Dedicated dredging for marsh restoration

Calcasieu Subbasin Perimeter Plan

- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Salinity control at Alkali Ditch
- New Lock at Gulf Intracoastal Waterway
- Modify existing Cameron-Creole Watershed control structures

Sabine Subbasin Perimeter Plan

- East Sabine Lake Hydrologic Restoration
- Salinity control at Black Bayou
- Salinity control at Highway 82 causeway

Mermentau Basin Freshwater Introduction

- Freshwater introduction at Pecan Island
- Freshwater introduction at Rollover Bayou
- Freshwater introduction at Highway 82
- Freshwater introduction at Little Pecan Bayou
- Freshwater introduction at South Grand Chenier

Major Features Requiring Further Study

◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands

◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7002

Subprovince 1, E1 (Minimize Salinity Changes)
• 5,000 cfs diversion at Convent / Blind River
• 10,000 cfs diversion at Bonnet Carre Spillway
• Sediment delivery via pipeline at Labranche Wetlands
• Sediment delivery via pipeline at Golden Triangle Area
• Sediment delivery via pipeline at Central Wetlands
• 6,000 cfs diversion at White's Ditch
• Sediment delivery via pipeline at American / California Bay
• Sediment delivery via pipeline at Quarantine Bay
• Sediment delivery via pipeline at Fort St. Philip
• 15,000 cfs diversion at American / California Bay
• 15,000 cfs diversion at Fort St. Philip
◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
Subprovince 2, E3 (Mimic Historic Hydrology)
• 5,000 cfs diversion @ Lac des Allemands with sediment enrichment
• 120,000 cfs diversion at Bayou Lafourche (Mississippi River Third Delta)
• Marsh creation @ Wetland Creation and Restoration feasibility study sites
• 90,000 cfs diversion @ Fort Jackson with sediment enrichment
• Relocation of deep draft navigation channel
• Barrier Island Restoration @Barataria Shoreline (3,000')
Subprovince 3, M1 (Maximize Geomorphic Features and River Influence)
• ◊ Third Delta (120,000 cfs diversion) with sediment enrichment
• Bayou Lafourche 1,000 cfs pump
• Relocate the Atchafalaya navigation channel
• Increase sediment transport down Wax Lake Outlet
• Rebuild Historic Reefs - Rebuild historic barrier between Point Au Fer and Eugene Island
• Rebuild Historic Reefs - Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to increase sediment transport and to benefit coastal wetlands
• Convey Atchafalaya River water to Terrebonne marshes
• Freshwater introduction via Blue Hammock Bayou
• Freshwater introduction south of Lake Decade
• Penchant Basin Plan
• Stabilize banks of Southwest Pass
• Maintain northern shore of East Cote Blanche Bay at Point Marone
• Rebuild Point Chevreuil Reef
• Rehabilitate Terrebonne barrier islands
• Rehabilitate northern shorelines of Terrebonne/Timbalier Bays
• Backfill pipeline canals
• Multi-purpose operation of the Houma Navigation Canal Lock
• Maintain land bridge between Bayous Dularge and Grand Caillou
• Maintain land bridge between Caillou Lake and the gulf
• Stabilize gulf shoreline
• Maintain Timbalier land bridge
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7002 (continued)

Subprovince 4, E2 (Perimeter Structure Salinity Control)
• Gulf Shoreline Stabilization • Calcasieu Ship Channel beneficial use • Dedicated dredging for marsh restoration **Calcasieu Subbasin Perimeter Plan** • Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • New Lock at Gulf Intracoastal Waterway • Modify existing Cameron-Creole Watershed control structures **Sabine Subbasin Perimeter Plan** • East Sabine Lake Hydrologic Restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway **Mermentau Basin Freshwater Introduction** • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovinces 1 and 2 - Mississippi River Delta Management Study.
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ Subprovinces 3 - Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to implementation).
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 10130

Subprovince 1, Modified M2 (Supplemental Framework)
• 5,000 cfs diversion at Convent/Blind River • 1,000 cfs diversion at Hope Canal • 10,000 cfs diversion at White's Ditch • 110,000 cfs diversion at American/California Bay with sediment enrichment • 12,000 cfs diversion at Bayou Lamoque • Increase Amite River influence by gapping dredged material banks on diversion canals • Sediment delivery via pipeline at Labranche ∀ Rehabilitate Violet Siphon and post authorization change for diversion of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands • Marsh nourishment on the New Orleans East land bridge ∀ Reauthorization of the Caernarvon freshwater diversion (optimize for marsh creation) ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study ∀ Authorized opportunistic use of the Bonnet Carre Spillway
Subprovince 2, Modified R1 (Supplemental Framework)
• 1,000 cfs diversion at Lac des Allemands • 1,000 cfs diversion at Donaldsonville • 1,000 cfs diversion at Pikes Peak • 1,000 cfs diversion at Edgard • Sediment delivery via pipeline at Myrtle Grove • 5,000 cfs diversion at Myrtle Grove • 60,000 cfs diversion at Boothville with sediment enrichment • Barrier Island Restoration @Barataria Shoreline (3,000') ∀ Reauthorization of Davis Pond • Marsh creation @ Wetland Creation and Restoration feasibility study sites ◊ Mississippi River Delta Management Study. ◊ Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to implementation).
Subprovince 3, Modified R1 (Supplemental Framework)
• Bayou Lafourche 1,000 cfs pump • Relocate the Atchafalaya navigation channel • Increase sediment transport down Wax Lake Outlet ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands • Convey Atchafalaya River water to Terrebonne marshes • Freshwater introduction via Blue Hammock Bayou • Penchant Basin Plan • Maintain northern shore of East Cote Blanche Bay • Rebuild Point Chevreuil Reef • Restore Terrebonne barrier islands ∀ Multipurpose operation of the Houma Navigation Canal (HNC) Lock • Maintain land bridge between Caillou Lake and the Gulf Mexico • Stabilize gulf shoreline • Maintain land bridge between Bayous Dularge and Grand Caillou.
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option* ∀ *Denotes features that operate under other existing authorities and have potential benefits that could be captured under the LCA Plan. Therefore, only benefits of the feature are included in analysis.*

Framework 10130 (continued)

Subprovince 4, Modified E2 (Supplemental Framework)
• Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • Modify existing Cameron-Creole Watershed control structures • East Sabine hydrologic restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier • Gulf Shoreline Stabilization • Calcasieu ship channel beneficial use • Black Bayou bypass culverts ◊ Chenier Plain Freshwater Management and Allocation Reassessment
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovinces 1 and 2 - Mississippi River Delta Management Study.
◊ Subprovinces 3 - Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ Subprovince 4 - Chenier Plain Freshwater Management and Allocation Reassessment
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option* ∀ *Denotes features that operate under other existing authorities and have potential benefits that could be captured under the LCA Plan. Therefore, only benefits of the feature are included in analysis.*

6.6 The Final Array of Coastwide Frameworks

6.6.1 Identification of the Final Array

While B2 was used as a metric in the IWR Plan, together with average annual cost, to narrow down the large number of possible coastwide frameworks to the final array, many other factors above must be considered in determining the framework which best meets the objectives of the planning effort. The benefits values have been presented here with consideration of the uncertainties of the models used to derive them, with particular emphasis on how these uncertainties might bias the benefits values towards frameworks that include one type of restoration feature versus another.

It is also important to consider how the use of B2 values might influence the nature of the final array. Discounting environmental benefits gives greater value to benefits that are achieved earlier in the project life compared to those achieved later. For instance, an acre of marsh built at year 5 might be valued higher, due to discounting, than an acre of marsh built at year 45. The implication is that frameworks that achieve benefits earlier in the time course of assessment are valued more than a framework that achieves the same benefits later, even if the average annual benefit is the same for both frameworks. It is possible that discounting benefits adds bias in favor of frameworks that use mechanical marsh creation approaches, versus those that rely on progressive delta building and wetland nourishment to increase land area. A possible compensating factor to this effect is the use of nitrogen removal (B4) as a component of the B2 value. This has an opposite effect since this value favors diversions, particularly larger diversions. Whether the net application of these factors actually results in a balanced assessment of frameworks is, however, uncertain.

6.6.1.1 Delta Plain – Deltaic Plain

The combinations of subprovince alternatives included in the final array were selected based upon cost estimates and the potential of these alternatives to achieve the LCA ecosystem objectives. In further considering the final array and determining the best approach to achieve LCA goals, a number of addition factors must be considered. For each of the coastwide frameworks, benefits metrics have been developed indicating the effect of the actions on specific aspects of the coastal ecosystem, such as land area and habitat for species of interest. These are used in considering the final array in addition to metrics that reflect the potential of the alternatives in reducing storm surge damage.

One of the most fundamental characteristics of coastal degradation in Louisiana is the loss of land (marsh, swamp, and barrier islands) to open water. **Figure E-35** shows the amount of land estimated to result from final array alternatives.

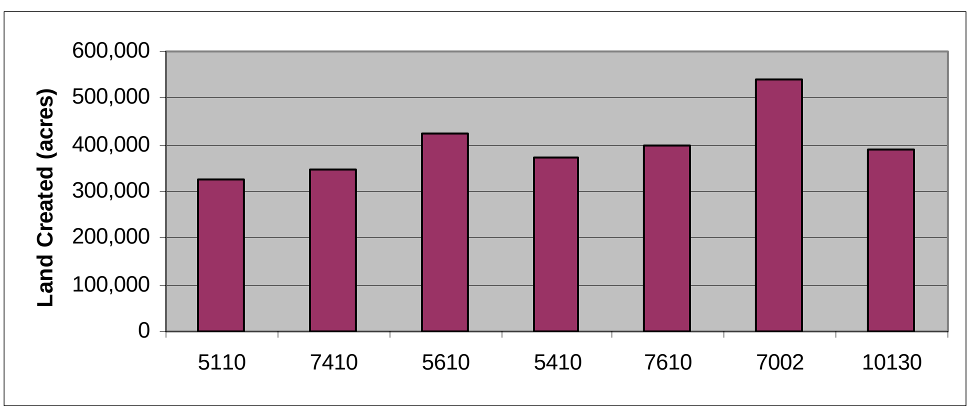


Figure E-35. Land Created by Final Array Coastwide Frameworks Compared to No Action Conditions. (No Action--Loss of over 400,000 acres by year 50)

The alternative which includes the Third Delta Conveyance Channel concept (7002) shows the highest amounts of land gain relative to No Action while several others (5610, 7610, and 10130) achieve approximately 400,000 acres of land more than would be present under No Action conditions. The features encompassed by the frameworks in the final array include very large diversions and small diversions, as well as mechanical marsh creation. Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" notes that there are limitations to the land building and nourishment desktop models that will affect all sizes of diversions. In addition, they note that estimates of land building by mechanical means, such as using dredging or sediment conveyance by pipeline, are likely to be more accurate. However, it is unclear that these limitations should prejudice any broad-scale consideration of the land building estimates in the final array. These limitations do, however, mean that relatively small differences in land building among frameworks are likely less important than overall trends, such as those described above.

An additional comparison between the frameworks in the final array related to land building, is how they performed relative to the initial planning scale estimates. These ecosystem planning scales were not design objectives but were preliminary estimates based on levels of land loss reduction. Each framework was developed around a particular scale to provide an overall range of output levels that would facilitate the identification of the most effective and efficient framework combinations.

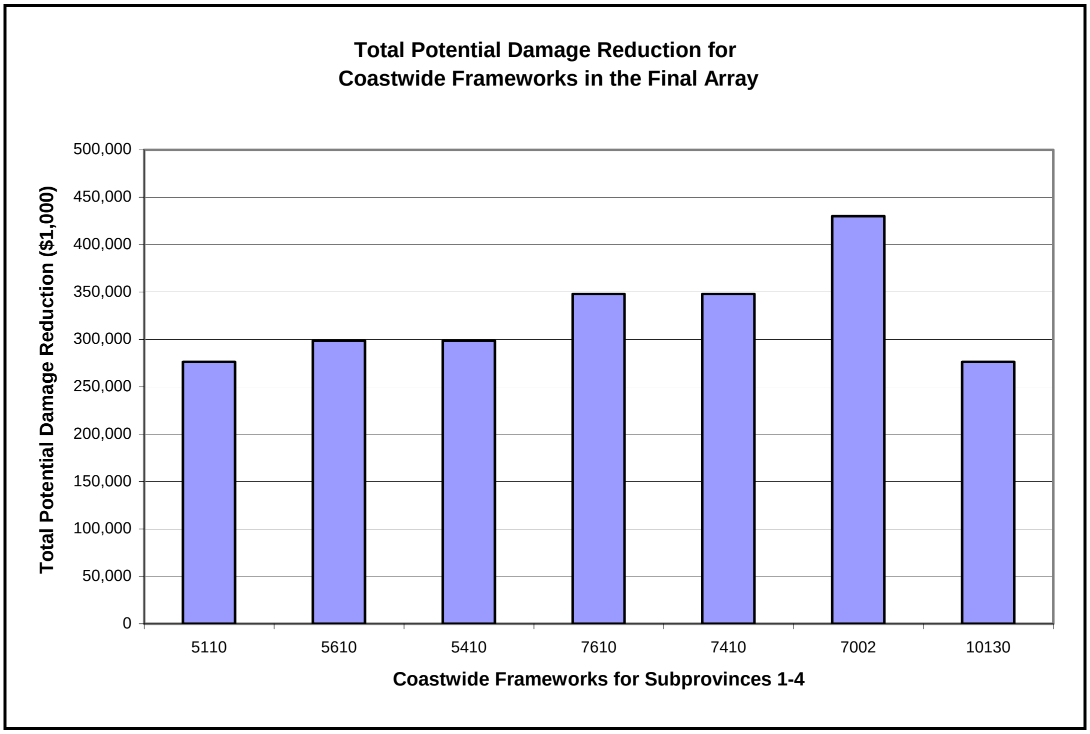
The land building output from the desktop modeling effort is presented for each framework in the final array, presented **table E-29**. This table readily displays that all of the frameworks included in the final array exceed the ecosystem scales on which they were based. Even though land building exceeded the preliminary ecosystem planning scales, the cost effective analysis was able to identify the most cost effective frameworks, regardless of the level of output.

As discussed previously, the use of acreage of land as a basis of the planning scales for this stage in the process in no way suggests that the other important objectives did not receive full consideration throughout the planning process. Acreage was used at this stage in the process not only because it was the simplest and most tangible feature around which alternatives could be formed, but also because it is an appropriate surrogate for the many important functions and values provided by Louisiana's coastal wetlands. In this sense, acreage was seen as an umbrella for the other objectives. Once alternatives were identified, the effects of alternatives relative to the other objectives were quantified during later stages of the planning process via hydrodynamic, ecological, and desktop modeling evaluations and benefit assessments.

Table E-29.
Comparison of Framework Performance Versus
Ecosystem Planning Scale Estimate.

Framework		***5110***	***7410***	***5610***	***5410***	***7610***	***7002***	***10130***
Land Created/ Preserved (ac/year)	SP 1	2,040	1,505	2,040	2,040	1,505	1,505	3,335
	SP 2	2,090	3,016	4,037	3,016	4,037	4,154	2,119
	SP 3	2,391	2,391	2,391	2,391	2,391	5,103	2,391
	SP 4	782	782	782	782	782	782	782
	TOTAL	**7,303**	**7,694**	**9,250**	**8,229**	**8,715**	**11,544**	**8,627**
Ecosystem Scale (ac/year)	SP 1	808	1,209	806	806	1,209	806	806
	SP 2	1,141	2,291	2,291	2,291	1,209	1,141	1,141
	SP 3	1,421	1,421	1,421	1,421	2,291	1,421	1,421
	SP 4	692	692	692	692	1,421	692	692
	TOTAL	**4,062**	**5,613**	**5,210**	**5,210**	**6,130**	**4,060**	**4,060**

Closely related to the amount of land versus water within the coastal system is the effect of reducing storm surge. In each subprovince the potential level of damage that would be incurred during a hypothetical hurricane was evaluated in terms of WRUs. WRUs are an accounting of numbers and values of structures, as well as the quantity and value of agricultural land, in an area. Storm surge reductions were estimated based on additional wetland acreage equivalent to the desired planning scale levels of Reduce, Maintain, and Increase for each subprovince. As the estimates are based on the scales rather than the modeling output, the limitations of land building estimates described above do not apply. Rather, a net potential damage reduction was developed for each scale level in each subprovince. The results of these analyses for the final array of frameworks are shown in **figure E-36**. As these analyses are based on the scale acreages, framework 10130 should be considered very similar to 5110.



Note: 1- All coastwide frameworks include Framework Increase 2 (E2) in Subprovince 4
2- Damage reduction values based on assessment of Water Resources Units

Figure E-36. Total Potential Damage Reduction for Coastwide Frameworks.

The differences between individual frameworks represent a change in potential storm damage reduction. An actual value for these changes in protection could be estimated by calculating a fully funded cost based on the difference in the value of potential damage reduction between frameworks. This would represent the dollar value of flood protection that the increment of damage could support. While these calculations have not been made, a rough estimate confirms that the difference between the values shown and the corresponding implementation value is on the same order of magnitude. In other words, the step to a larger framework based on this particular feature of output would not be cost-effective.

Examination of storm damage reduction data for all alternatives indicates that frameworks in the final array that achieve a level of potential damage reduction less than the maximum typically are more cost-effective in achieving these outputs. Frameworks 5110, 5410, 5610, 10130, 7410, and 7610, which form the breakpoint of the cost-effective curve, tend to be the most cost-effective in achieving potential damage reduction but do not provide the greatest level of that output.

The comprehensive benefit protocol (B2) used in the cost-effectiveness analysis assesses the success of the frameworks in achieving the ecosystem objectives of LCA as well as the land building potential. To consider the final array of frameworks, in terms of their success in achieving individual ecosystem benefits, benefits protocols B1 and B4 were developed (Hawes et al. 2003). B1 can be used to examine the frameworks in terms of ecosystem primary productivity and provision of fish and wildlife habitat. **Figure E-37** shows the performance of the final array for B1 relative to No Action.

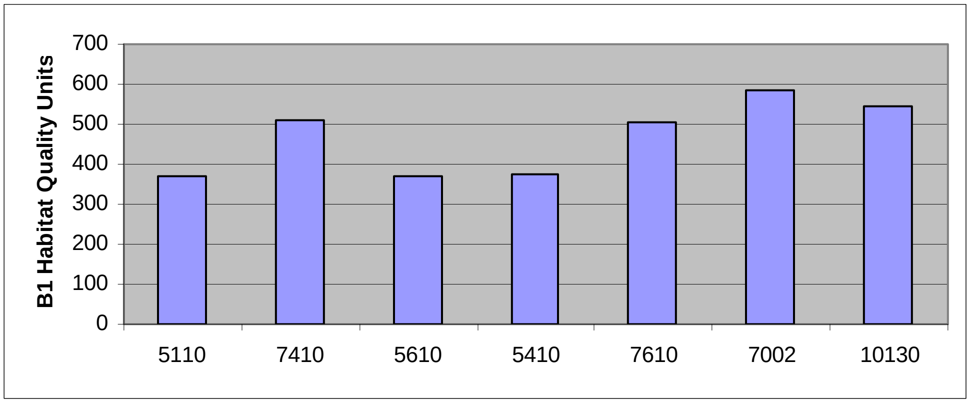


Figure E-37. Net Mean Annual Habitat Quality Units (Benefits Protocol B1) for the Final Array Coastwide Frameworks Compared to No Action Conditions (No Action at Year 50= 5,700 HQUs).

The limitations of the modeling on which the benefits calculations are based should be further considered here as the Habitat Quality Units and include estimates of habitat suitability for selected fish and wildlife species using the estuary. Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" notes that the box models used to estimate salinity changes across subprovinces mask salinity gradients within a box. Some of the species, (birds, mammals, reptiles) respond more to the vegetated community type, while others (fish, shrimp, oysters) respond to changes in salinity along the estuarine gradient. This means that some species are more sensitive to abrupt changes in the salinity gradient due to model limitations. Habitat for species that use higher salinity areas of the estuary are thus likely underestimated, while moderate salinity habitat is probably overestimated. B1 Habitat Quality Units include categories for habitats in low, moderate, and higher salinity environments. To some extent the uncertainties in habitat suitability predictions may counteract one another, but it is likely that B1 values for frameworks including very large diversions are more uncertain than for other frameworks, as these limitations to the modeled salinity gradient are more pronounced for large diversions.

The variation in B1 Habitat Quality Units should be used to show broad scale differences among frameworks, with less benefit over No Action (e.g., 5110, 5610 and 5410), compared to those with higher benefits (e.g., 7002 and 10130), rather than to provide a relative measure of performance between individual frameworks, see **figure E-37**.

The second LCA ecosystem objective concerns reducing nutrient delivery to the shelf by routing Mississippi River water through estuarine basins. The B4 benefit protocol is used to reflect success in achieving this objective and is shown in **figure E-38**.

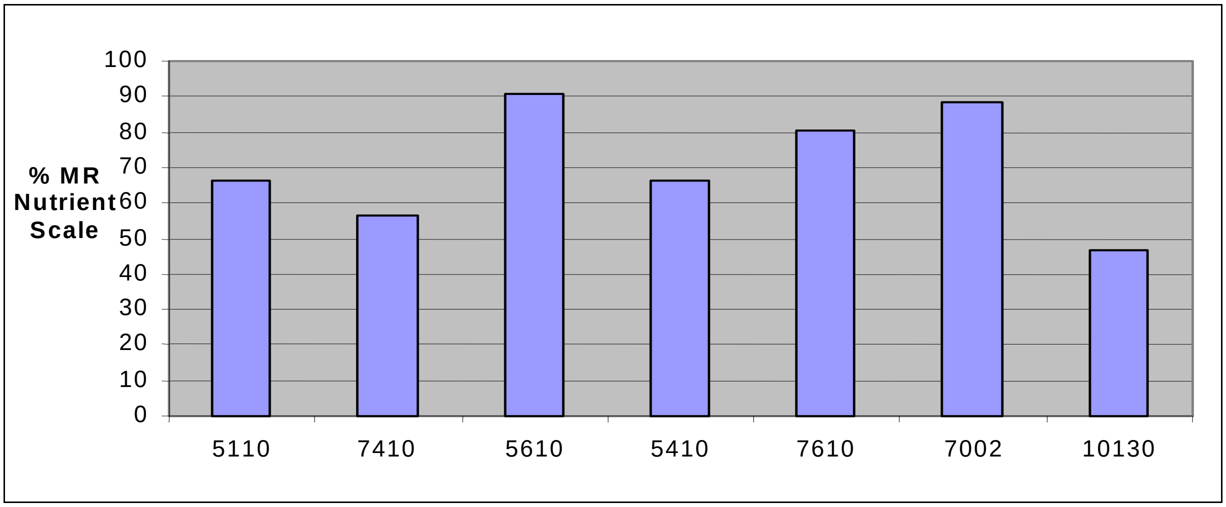


Figure E-38. Mean Annual Percent of Mississippi River Nutrient Reduction Scales Achieved (Benefits Protocol B4) for the Final Array Coastwide Frameworks (Initial Results) Compared to No Action Conditions. (No Action – Over 96 Percent, Includes Removal from Atchafalaya River Waters in Subprovince 3 Under Existing Configuration).

The reduction in nutrients reaching the shelf is shown in **figure E-38** as the percentage of the Mississippi River nutrient reduction scale achieved by the framework (100 percent would be equivalent to the total reduction scale of 30 percent, not all of the nutrients present in the river). The uncertainties in modeling identified by Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" suggest that the nutrient reduction potential of very large river diversions is likely underestimated in the analyses presented here. They also note that there may be some, but much smaller in absolute magnitude, overestimates for smaller diversions. **Figure E-38** also shows the frameworks that include the Third Delta Conveyance Channel concept or other large diversions with high nutrient removal, despite these limitations.

Given the programmatic nature of the LCA Plan, the results of this modeling effort serve primarily to differentiate among alternatives with respect to their relative impacts on Gulf hypoxia. Accurate, quantitative estimates of the effects of particular restoration features on Gulf hypoxia will be developed at the project-level, when critical information regarding the location, size, and operation of such features will be available.

As well as assessing the frameworks relative to LCA ecosystem objectives, benefits protocols have been developed to identify the effects of frameworks on habitats for particular species groupings. **Table E-30** shows an assessment of framework effects on habitat for species using lower, moderate, and higher salinity zones of the estuary, and habitats for selected species grouped according to their importance for commercial harvest and recreational use, with oyster habitat shown individually. Importantly, the magnitude of negative values for the differences between frameworks and No Action conditions should be considered relative to absolute values for No Action to more fully assess the nature of the potential impact. This shows that for the most part negative values for moderate salinity habitats and habitats for commercial and recreational species groups are very small compared to no action predictions, generally representing less than a 5 percent change. Differences are greater for oysters and the higher salinity species grouping. However, as has already been recognized, the modeling approaches used in this study mask changes in the salinity gradient, and this is particularly the case at the higher salinity range. Thus, the values in **table E-30** of potential impact to oyster habitats and habitat for higher salinity species (including oysters) are overestimates. For oysters and higher salinity species habitats, the values are best interpreted to show the differences among the coastwide frameworks in terms of their greater or lesser effects rather than to project the magnitude of benefits or impacts to habitats for species groups.

Table E-30.
Mean Annual Habitat Units for B6 Species Groupings for the Final Array Coastwide Frameworks Compared to No Action Conditions.
Values for No Action year 50 conditions included for reference.

	Species Habitat Grouping					
Mean Annual Habitat Units for Coastwide Frameworks At Year 50	**Lower Salinities**	**Moderate Salinities**	**Higher* Salinities**	**Commercial Species**	**Recreational Species**	**Oysters ***
No Action	5,473	13,254	10,215	11,246	8,820	8,480
(Framework minus No Action)						
5110	740	-187	-2,119	-639	-187	-2,450
7410	652	63	-1,586	-364	-78	-1,739
5610	910	-351	-2,502	-896	-76	-2,574
5410	774	-207	-2,116	-651	-166	-2,450
7610	788	-81	-1,972	-610	12	-1,863
7002	799	-206	-2,232	-881	82	-2,629
10130	777	11	-1,923	-462	-95	-2,452

* *See text for limitations*.

The frameworks within the final array include many different types and scales of restoration features. One way in which the types of features can be gauged is by the amount of Mississippi River water and suspended sediment diverted into the estuarine basins. Frameworks which rely on more mechanical means of marsh creation to achieve land building (**figure E-38**) will divert less suspended sediment than those that rely on natural delta-building processes. **Figure E-39** shows the variation in sediment diverted for the final array frameworks. With the exception of Subprovince 3, where Atchafalaya River waters distribute sediments, very little suspended sediment reaches the estuarine basins under No Action conditions.

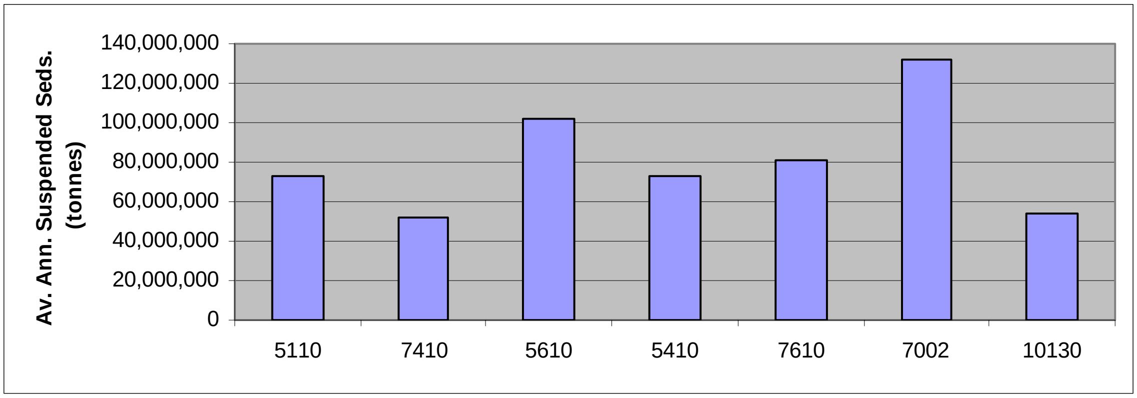


Figure E-39. Annual Amount of Suspended Sediment Diverted into Estuarine Basins for Each Coastwide Framework in the Final Array.

In comparing the coastwide frameworks in the final array, it can be readily observed that the individual frameworks each have strengths in different areas of output. Framework 7002 results in the largest magnitude of outputs in several benefit categories. However, the overall size of the framework also results in the largest costs and, as a result, a cost-effectiveness that appears far above the breakpoint of the cost-effective curve.

In terms of land building (B3) frameworks 5610, 7610, and 10130 are the next most productive. In the measure of overall habitat quality (B1) output frameworks 10130, 7410, and 7610 are the most productive. This relative effectiveness may also be observed in the detailed habitat output data presented in **table E-30** for various composite salinity and species groups. These same three frameworks appear to provide some balance of outputs across these diverse groups.

Two benefit metrics involve the introduction of riverine resource to the wetlands. For benefit metric B4, the ability of the frameworks to address the Mississippi River nutrient reduction scale frameworks 5610, 7002 and 7610 address the largest percentages. This is the only graphed metric in which framework 7002 does not produce the largest effect. The minimum percentage of the scale addressed by any framework is slightly less than 50 percent. Looking into the future, an increase in the ecosystems ability to utilize nitrogen should be a secondary effect of increased wetland building and overall habitat quality.

The second metric involving riverine resources is the introduction of suspended sediment. For this metric the frameworks that divert the largest volume of river water would obviously produce the largest effect. Beyond framework 7002, framework 5610 produces the most significant effect for this metric. It should be noted that this metric does not account for sediments dredged from the river, which is accounted for in the land building metric.

After review of this information, as well as the cost-effectiveness analysis, it appears that frameworks 7610 and 10130 produce very similar suites of beneficial output. While framework 10130 does sacrifice some nutrient utilization, it produces better composite habitat output (B1) and only slightly less land building (B3). In terms of cost-effectiveness, framework 10130 results in a lower overall cost and slightly lower unit cost then framework 7610. In addition, framework 10130 represents the modified supplemental framework to the final array. This framework is a consensus framework developed and analyzed to ensure, to the maximum extent possible, the inclusion of environmentally significant features as well as completeness and cost-effectiveness.

6.6.1.2 Chenier Plain - Subprovince 4

In Subprovince 4, the primary benefit variable used to identify the cost-effective frameworks was B3: Land Building. The relative success of the Subprovince 4 alternatives in creating or preserving land is shown in **figure E-40**. There are two main groupings of frameworks. M1 and E1 produce less than 33,000 acres of land relative to No Action while all other frameworks create around 40,000 acres.

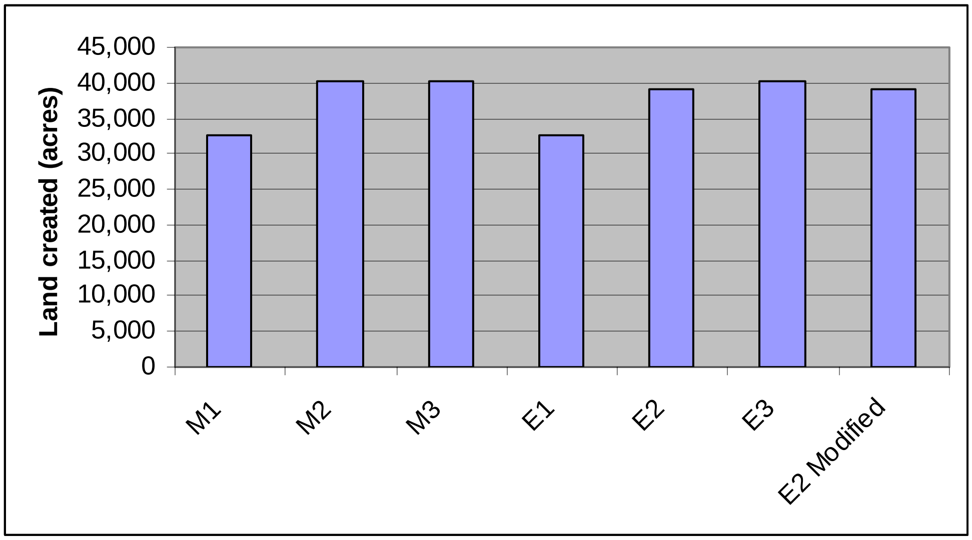


Figure E-40. Land Created by Subprovince 4 Frameworks Compared to No Action Conditions. (No Action - Loss of Over 47,000 Acres by Year 50).

Benefits protocol B1 can be used to examine the frameworks in terms of their net ecosystem primary productivity and provision of fish and wildlife habitat. The No Action value for Habitat Quality Units (B1) at year 50 for Subprovince 4 is 2,250. While all the mean annual values for the alternatives are less than this, implying negative benefit or impact, the change from No Action is less than 5 percent. These values for the Chenier Plain are also subject to the same methodological limitations as described for the Deltaic Plain above. Given these limitations and the small changes from the No Action conditions described by B1 for the alternatives, B1 cannot be used to distinguish among alternative frameworks in the Chenier Plain.

Table E-31 shows an assessment of Subprovince 4 alternative framework effects on habitat for species using lower, moderate and higher salinity zones of the estuary, and habitats for selected species grouped according to their importance for commercial harvest and recreational use, with oyster habitat shown individually. Importantly, the magnitude of negative values for the differences between frameworks and No Action conditions should be considered relative to absolute values for No Action to more fully assess the nature of the potential impact. With the exception of oysters, the effects of the alternatives on habitat for the species groupings are relatively minor. As discussed above, modeling approaches used in this study likely result in underestimates of species habitats in higher salinity areas of the estuary. Although the magnitude of the differences among alternatives is small relative to No Action, it does appear that alternatives E2 and "E2 Modified" provide slightly improved habitats for fresher species groupings and concomitantly present slightly more risk to habitats for moderate and higher salinity species groupings.

Table E-31.
Mean Annual Habitat Units for B6 Species Groupings for the Subprovince 4 Alternative Frameworks Compared to No Action Conditions.
Values for No Action year 50 conditions included for reference.

	Species Habitat Groupings					
Mean Annual Habitat Units for Chenier Plain Frameworks At Year 50	**Low**	**Moderate**	**Higher**	**Commercial**	**Recreational**	**Oysters**
No Action	1,535	2,621	1,482	2,000	1,854	408
(Framework Minus No Action)						
M1	-121	-47	27	-72	-58	-111
M2	-130	-71	35	-79	-73	-35
M3	-130	-70	36	-78	-73	-34
E1	-121	-47	27	-72	-58	-111
E2	-25	-135	-114	-105	-77	-45
E3	-130	-70	36	-78	-73	-34
E2 Modified	-25	-135	-114	-105	-77	-45

The objective of salinity management capability in this subprovince is indicative of the limited freshwater resources available and the need to preserve and maintain fresh marsh habitat. As can be seen in **table E-31**, frameworks E2 and “E2 Modified” present a better opportunity to achieve lower salinity related outputs.

Following are the implementation costs and O&M costs for each framework in the final array broken down by subprovince.

6.6.2 Ecosystem Sustainability

The USACE Environmental Operating Principles promote projects that "Strive to achieve environmental sustainability." The need to move towards ecosystem sustainability was considered throughout the LCA planning process, from development of the Study Guiding Principles and identification of core ecosystem restoration strategies to the formulation of specific features and coastwide alternatives.

The Study Guiding Principles call for achieving "ecosystem sustainability" and have a strong preference for alternatives that "mimic natural processes and rely on natural cycles and processes for their operation and maintenance." In identifying core strategies for restoration, members of the Framework Development Team emphasized these same concepts. Most notably, the core strategies identified for the Deltaic Plain center around river re-introduction as the primary way to restore some semblance of the natural processes that create and sustain deltaic wetlands. Consistent with this core strategy, approximately three fourths of the potential restoration features identified for Subprovinces 1 and 2 involve river re-introduction. Most of the remaining features in those subprovinces are designed to provide near-term solutions and/or restore critical structural features of the ecosystem.

The emphasis on river re-introduction and sustainability was carried forward into the development of the subprovince alternatives. River-reintroduction is the foundation of two of the three conceptual frameworks used to develop alternatives for Subprovinces 1 and 2. For example, the "mimic natural hydrology" framework seeks to replicate the natural over-bank flow, crevassing, and distributary flow characteristic of the deltaic system. Moreover, smaller diversions are included in the alternatives that have a greater emphasis on marsh creation in an effort to extend the duration and effectiveness of such features. As a result of this continuous emphasis on sustainability, the final array alternatives, while representing a mix of approaches to coastal restoration, nevertheless rely extensively on river-reintroduction projects for restoring coastal Louisiana.

The final array alternatives have the potential to provide environmental benefits throughout the 50-year planning period. The potential environmental benefits of the frameworks in the final array have been estimated based on the output of the models used for the LCA Ecosystem Restoration Study. **Figure E-41** shows the “B2” benefits over ten year intervals for each framework in the final array and the No Action alternative. (The “B2” benefits represent habitat quantity and quality, and the nutrient removal capacity of each framework.) **Figure E-41** shows that each framework would have a substantial and sustained increase in “B2” benefits. It is important to note that the actual rate at which the frameworks would provide the estimated environmental benefits would depend upon the timing and sequence of implementation of the specific features contained within the respective framework. However, it is expected, based on the reasons discussed above, that the realized effect of the LCA frameworks relative to sustainability would be consistent with the trends identified in **figure E-41**.

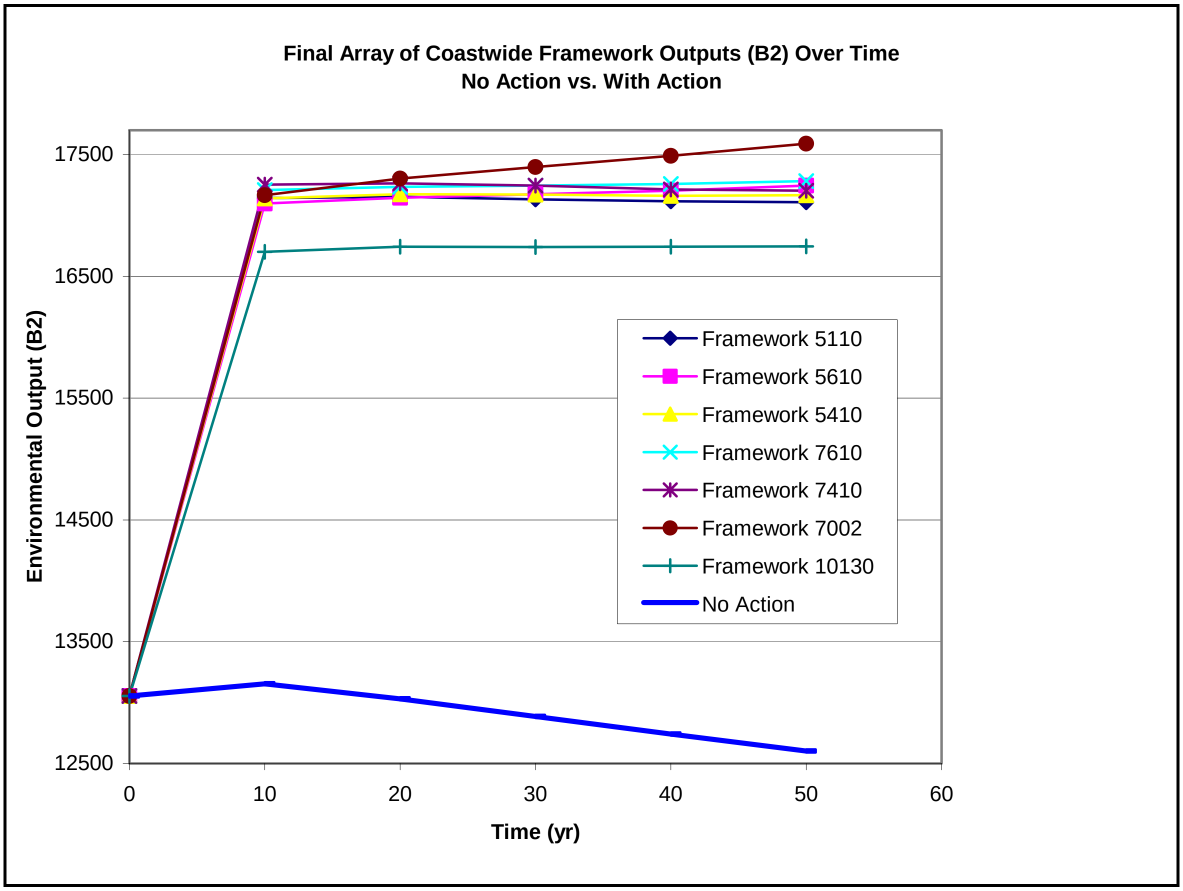


Figure E-41. Final Array of Coastwide Frameworks Outputs (B2) Over Time for Subprovinces 1-3.

The final array alternatives also have the potential to provide environmental benefits beyond the 50-year framework horizon. For example, river re-introduction features have the potential to continue to provide benefits as long as such structures are maintained and operated in a manner consistent with existing ecosystem needs. Additionally, in the case of river re-introduction features, the bulk of the cost is concentrated in the design and construction stages. Accordingly, the long-term benefits (i.e., those beyond 50 years) come at minimal cost. Moreover, the complex issues identified for further study as part of the LCA Report (e.g., the Third Delta, relocation of navigation channel) are actions that would have long-term effects well beyond the 50-year framework horizon, either by mimicking natural deltaic process (as is the case with the Third Delta) or by enabling the return of more natural deltaic dynamics along the Mississippi River (as in the case of the proposal to relocate the navigation channel).

Inspection of the with-project action versus No Action trends for the individual alternative frameworks, which make up the final array in each of Subprovinces 1and 2, reveals a similar pattern of sustainability (**figures E-42 and E-43**). In Subprovince 3 although some with-action alternatives show a decreasing trend over the 50-year period of analysis, the slope of decline is reduced (**figure E-44**). This is consistent with the possible conceptual scenarios for coastal restoration since degradation is a natural function necessary in the system. The modification of the rate of decline indicates an extension in the sustainable life of the system. This would be particularly applicable in an older deltaic system. It can be seen in the composite chart of B2 outputs for Deltaic Plain shown above that overall trends in the coastwide frameworks in the final array are typically stable.

In Subprovince 4 the B2 output value did not apply due to the nature of the Chenier Plain system. In place of B2, land building was used. As can be seen in **figure E-45** the trends in this subprovince are similar to those seen in Subprovince 3. Again this is consistent with a trend of sustainability in an managed system and the described conceptual restoration scenarios.

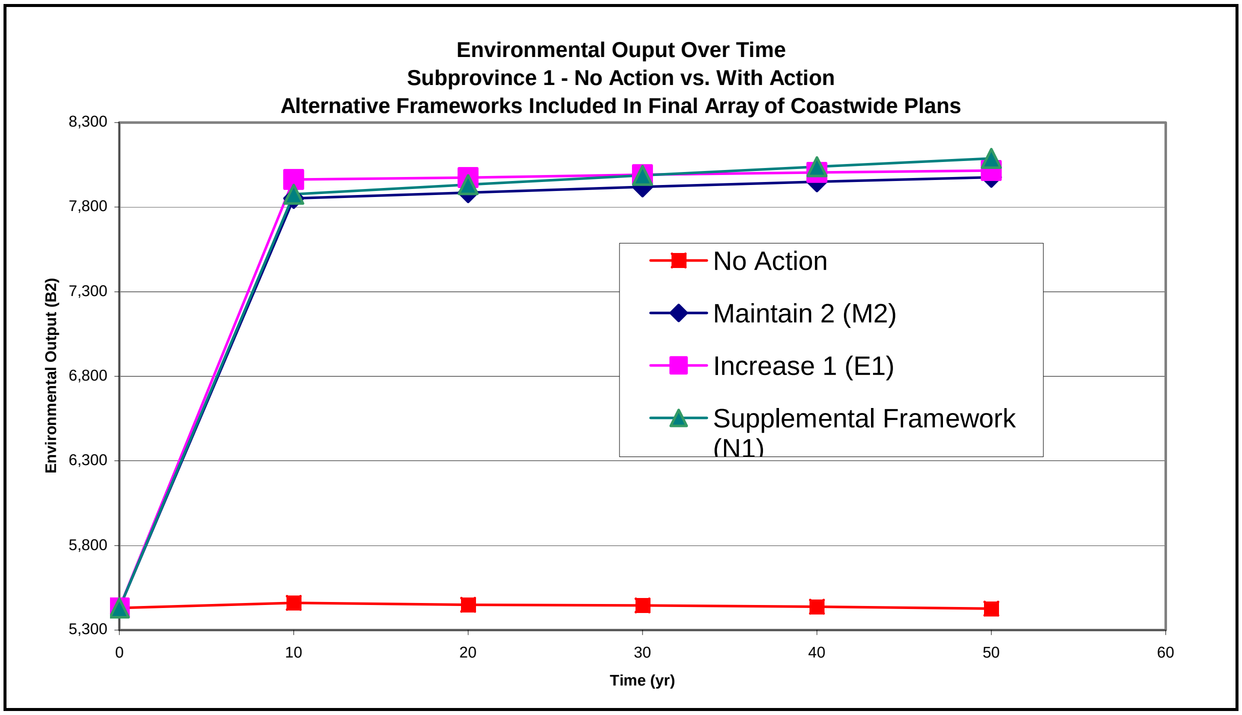


Figure E-42. Environmental Output (B2) Over Time. Subprovince 1 – No Action vs. With Action.

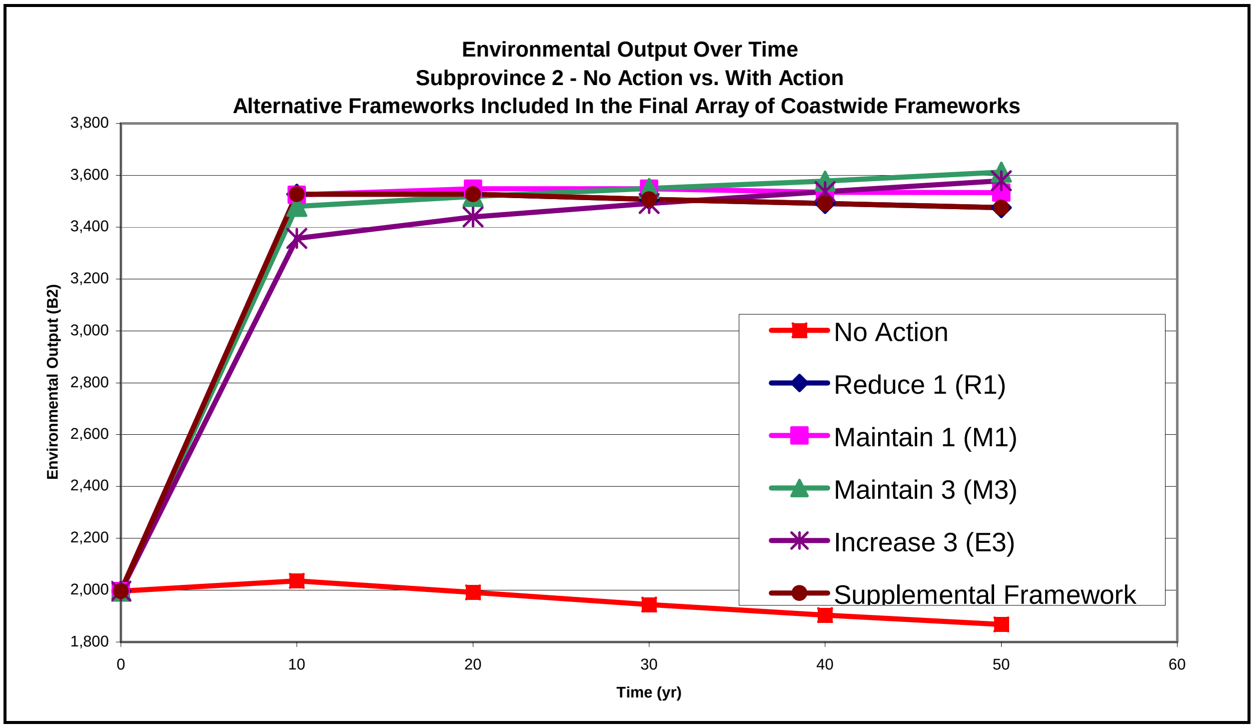


Figure E-43. Environmental Output (B2) Over Time. Subprovince 2 – No Action vs. With Action.

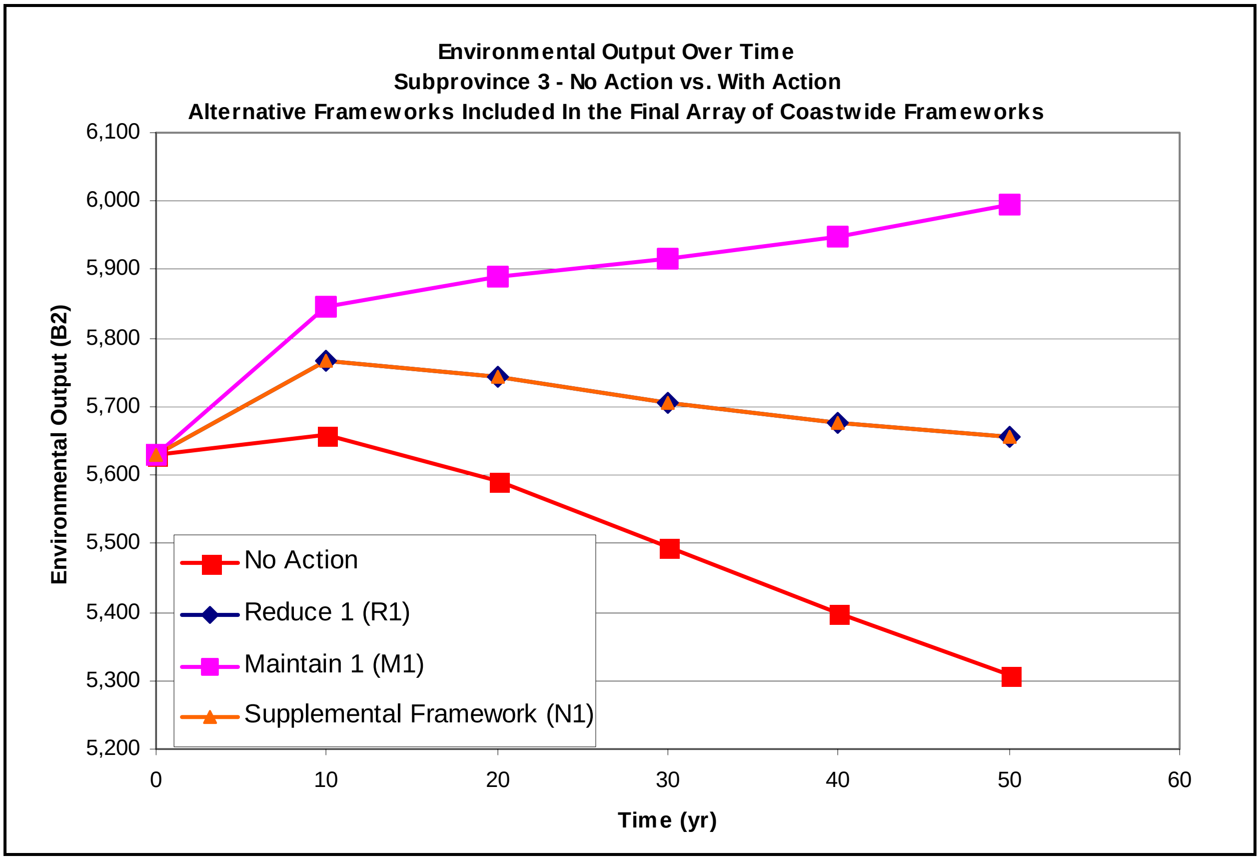


Figure E-44. Environmental Output (B2) Over Time. Subprovince 3 – No Action vs. With Action.

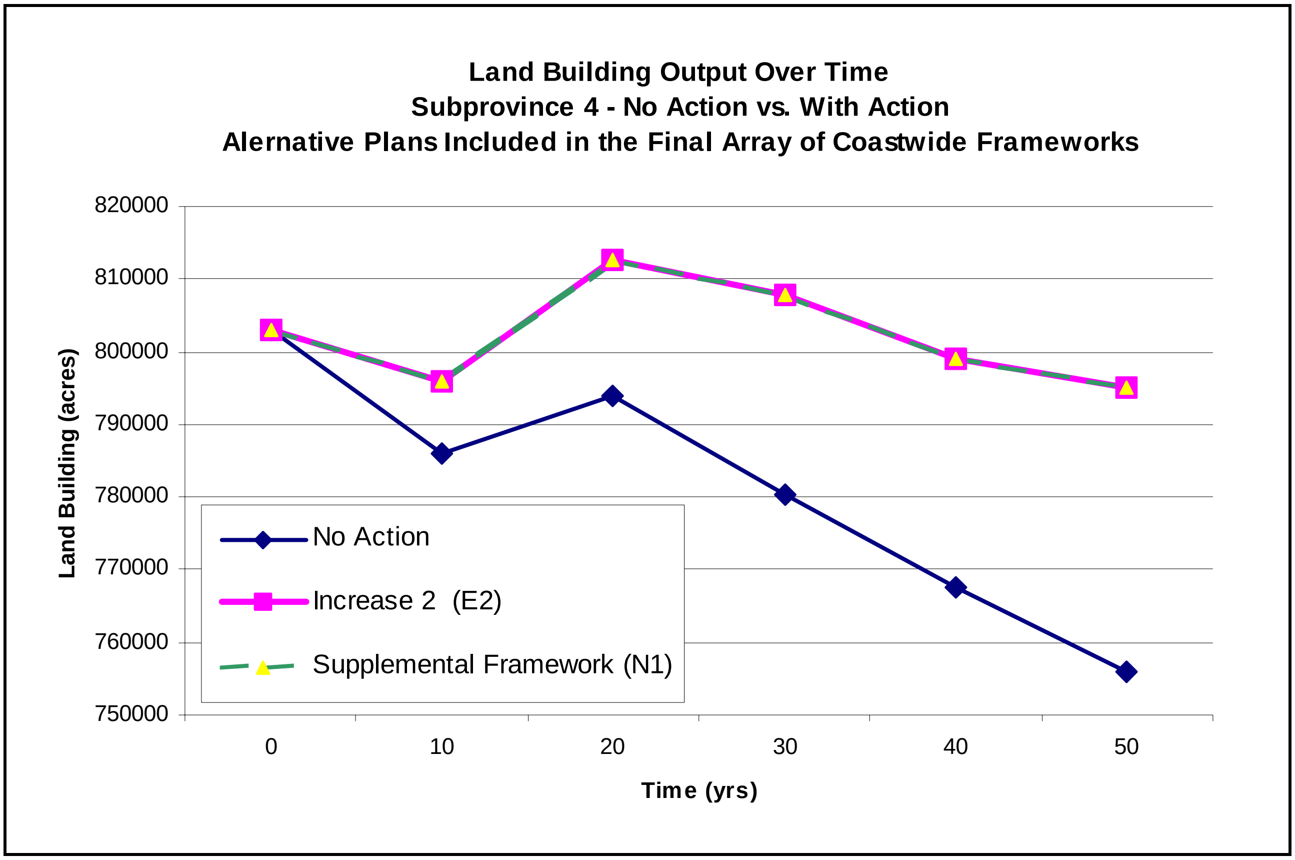


Figure E-45. Environmental Output (Land Building – B3) Over Time. Subprovince 4 – No Action vs. With Action.

The following tables (**tables E-32 to E-45)** present the cost estimates for the subprovince alternative frameworks included in each of the coastwide alternative frameworks in the final array. In addition, a summary cost table showing total cost across the four subprovinces, is provided for each of the coastwide alternative frameworks in the final array.

Table E-32.
Framework 5110 Subprovince 1 -- M2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
	SUBTOTAL	$	227,684,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study
Relocations		$	6,028,000
	SUBTOTAL	$	233,712,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	63,102,240
Real Estate		$	187,794,000
	SUBTOTAL	$	484,608,240
Monitoring		$	4,846,082
Adaptive Management		$	14,538,247
	TOTAL IMPLEMENTATION COST	**$**	**503,992,570**
O&M - Structures	$ 416,236		
O&M - Implementation	$ 15,742,500		
TOTAL O & M COST	**$ 16,158,736**		

Table E-32.
Framework 5110 Subprovince 2 --R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion at Edgard		$	28,200,000
Sediment Enrichment at Edgard		$	75,000,000
5,000 cfs diversion at Myrtle Grove		$	34,300,000
Sediment delivery via pipeline at Myrtle Grove		$	112,000,000
Marsh Creation Study Sites		$	300,113,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
60,000 cfs diversion @ Ft. Jackson		$	16,800,000
	SUBTOTAL	$	2,196,473,000
Relocations		$	400,000
	SUBTOTAL	$	2,196,873,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	593,155,710
Real Estate		$	224,126,000
	SUBTOTAL	$	3,014,154,710
Monitoring		$	30,141,547
Adaptive Management		$	90,424,641
	TOTAL IMPLEMENTATION COST	**$**	**3,134,720,898**
O&M - Structures	$ 268,623		
O&M - Implementation	$ 12,678,000		
TOTAL O & M COST	**$ 12,946,623**		

Table E-32.
Framework 5110 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Freshwater intro South of Lake Decade		$	2,200,000
Penchant Basin Plan		$	9,720,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island		$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island		$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands			Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate Costs
Relocations		$	14,000,000
	SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	138,866,400
Real Estate		$	80,577,000
	SUBTOTAL	$	733,763,400
Monitoring		$	7,337,634
Adaptive Management		$	22,012,902
TOTAL IMPLEMENTATION COST		**$**	**763,113,936**
O&M – Structures	$ 5,164,478		
O&M – Implementation	$ -		
TOTAL O & M COST	**$ 5,164,478**		

Table E-32.
Framework 5110 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine Hydrologic Restoration	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-33.
Framework 5110
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 92,684,000	$ 1,068,873,000	$ 500,320,000	$ 285,798,000	$ 1,947,675,000
Continuing Construction Cost	$ 135,000,000	$ 1,202,600,000	$ -	$ -	$ 1,337,600,000
Real Estate	$ 187,794,000	$ 224,126,000	$ 80,577,000	$ 21,891,000	$ 514,388,000
Relocations	$ 6,028,000	$ 400,000	$ 14,000,000	$ -	$ 20,428,000
E&D / S&A	$ 63,102,240	$ 593,155,710	$ 138,866,400	$ 77,165,460	$ 872,289,810
Monitoring & Adaptive Management	$ 19,384,330	$ 120,566,188	$ 29,350,536	$ 15,394,178	$ 184,695,232
Total Construction	$ 503,992,570	$ 3,134,720,898	$ 763,113,936	$ 400,248,638	$ 4,802,076,042
Project Implementation Reports (GI)					$ 240,103,802
PED					$ 144,062,281
				Total Cost	$ 5,186,242,126
				Total Cost Rounded	$ 5,186,000,000
Annual Costs					
O&M - Structures	$ 416,236	$ 268,623	$ 5,164,478	$ 3,031,076	$ 8,880,413
O&M - Implementation	$ 15,742,500	$ 12,678,000	$ -	$ -	$ 28,420,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 45,300,913
				Total Annual Cost Rounded	$ 45,000,000

Table E-34.
Framework 7410 Subprovince 1 – E1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)	
IMPLEMENTATION COSTS				
5,000 cfs diversion @ Convent / Blind River.			$	42,700,000
Sediment delivery via pipeline @ Labranche Wetlands			$	138,750,000
10,000 cfs diversion @ Bonnet Carrie spillway			$	141,600,000
Sediment delivery via pipeline @ Central Wetlands			$	151,250,000
Sediment delivery via pipeline @ Golden Triangle Area			$	138,750,000
6,000 cfs diversion @ White’s Ditch			$	20,700,000
Sediment delivery via pipeline @ American / California Bay			$	363,750,000
Sediment delivery via pipeline @ Quarantine Bay			$	338,750,000
Sediment delivery via pipeline @ Fort St. Phillip			$	158,750,000
15,000 cfs diversion @ American / California Bay			$	5,000,000
15,000 cfs diversion @ Fort St. Phillip			$	4,800,000
		SUBTOTAL	$	1,504,800,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study	
Relocations			$	3,230,000
		SUBTOTAL	$	1,508,030,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	407,168,100
Real Estate			$	171,228,000
		SUBTOTAL	$	2,086,426,100
Monitoring			$	20,864,261
Adaptive Management			$	62,592,783
TOTAL IMPLEMENTATION COST			**$**	**2,169,883,144**
O&M – Structures	$	525,346		
O&M – Implementation	$	8,364,000		
TOTAL O & M COST	**$**	**8,889,346**		

Table E-34.
Framework 7410 Subprovince 2 --M1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
5,000 cfs diversion @ des Allemands			$	34,700,000
des Allemands sediment enrichment			$	75,000,000
Sediment delivery via pipeline at Myrtle Grove			$	176,250,000
5,000 cfs diversion at Myrtle Grove			$	34,300,000
Barrier Island restoration at Barataria Shoreline.			$	502,460,000
Barrier Island Renourishment			$	1,127,600,000
60,000 cfs diversion @ Boothville			$	16,800,000
Sediment delivery via pipeline @ Empire			$	166,250,000
Sediment delivery via pipeline @ Bastion Bay			$	123,750,000
Sediment delivery via pipeline @ Head of Passes			$	743,750,000
Marsh creation @ Marsh creation feasibility study sites			$	300,113,000
		SUBTOTAL	$	3,300,973,000
Relocations			$	950,000
		SUBTOTAL	$	3,301,923,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	891,519,210
Real Estate			$	312,837,000
		SUBTOTAL	$	4,506,279,210
Monitoring			$	45,062,792
Adaptive Management			$	135,188,376
		TOTAL IMPLEMENTATION COST	**$**	**4,686,530,378**
O&M - Structures	$	268,623		
O&M - Implementation	$	12,678,000		
TOTAL O & M COST	**$**	**12,946,623**		

Table E-34.
Framework 7410 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Freshwater intro South of Lake Decade		$	2,200,000
Penchant Basin Plan		$	9,720,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island		$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island		$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands			Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate cost
Relocations		$	14,000,000
	SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	138,866,400
Real Estate		$	80,577,000
	SUBTOTAL	$	733,763,400
Monitoring		$	7,337,634
Adaptive Management		$	22,012,902
TOTAL IMPLEMENTATION COST		**$**	**763,113,936**
O&M - Structures	$ 5,164,478		
O&M - Implementation	$ -		
TOTAL O & M COST	**$ 5,164,478**		

Table E-34.
Framework 7410 Subprovince 4 – E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine HR	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-35.
Framework 7410
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 1,504,800,000	$ 2,098,373,000	$ 500,320,000	$ 285,798,000	$ 4,389,291,000
Continuing Construction Cost	$ -	$ 1,202,600,000	$ -	$ -	$ 1,202,600,000
Real Estate	$ 171,228,000	$ 312,837,000	$ 80,577,000	$ 21,891,000	$ 586,533,000
Relocations	$ 3,230,000	$ 950,000	$ 14,000,000	$ -	$ 18,180,000
E&D / S&A	$ 407,168,100	$ 891,519,210	$ 138,866,400	$ 77,165,460	$ 1,514,719,170
Monitoring & Adaptive Management	$ 83,457,044	$ 180,251,168	$ 29,350,536	$ 15,394,178	$ 308,452,927
Total Construction	$ 2,169,883,144	$ 4,686,530,378	$ 763,113,936	$ 400,248,638	$ 8,019,776,097
Project Implementation Reports (GI)					$ 400,988,805
PED					$ 240,593,283
				Total Cost	$ 8,661,358,185
				Total Cost Rounded	$ 8,661,000,000
Annual Costs					
O&M - Structures	$ 525,346	$ 268,623	$ 5,164,478	$ 3,031,076	$ 8,989,523
O&M - Implementation	$ 8,364,000	$ 12,678,000	$ -	$ -	$ 21,042,000
Science Plan					$ 8,000,000
				Total Annual Cost	$ 38,031,523
				Total Annual Cost Rounded	$ 38,000,000

Table E-36.
Framework 5610 Subprovince 1 – M2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
	SUBTOTAL	$	227,684,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study
Relocations		$	6,028,000
	SUBTOTAL	$	233,712,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	63,102,240
Real Estate		$	187,794,000
	SUBTOTAL	$	484,608,240
Monitoring		$	4,846,082
Adaptive Management		$	14,538,247
	TOTAL IMPLEMENTATION COST	**$**	**503,992,570**
O&M – Structures	$ 416,236		
O&M – Implementation	$ 15,742,500		
TOTAL O & M COST	**$ 16,158,736**		

Table E-36.
Framework 5610 Subprovince 2 --M3
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs diversion @ des Allemands			17,000,000
1,000 cfs diversion @ Donaldsonville		$	14,500,000
1,000 cfs diversion @ Pikes Peak		$	11,800,000
1,000 cfs diversion @ Edgard		$	13,100,000
75,000 cfs diversion @ Myrtle Grove		$	357,700,000
Sediment Enrichment at Myrtle Grove		$	250,000,000
60,000 cfs diversion @ Fort Jackson		$	16,800,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
	SUBTOTAL	$	2,310,960,000
Relocations		$	4,620,000
	SUBTOTAL	$	2,315,580,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	625,206,600
Real Estate		$	382,625,000
	SUBTOTAL	$	3,323,411,600
Monitoring		$	33,234,116
Adaptive Management		$	99,702,348
	TOTAL IMPLEMENTATION COST	**$**	**3,456,348,064**
O&M - Structures	$	724,406	
O&M - Implementation	$	11,104,500	
TOTAL O & M COST	**$**	**11,828,906**	

Table E-36.
Framework 5610 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Freshwater intro South of Lake Decade		$	2,200,000
Penchant Basin Plan		$	9,720,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island		$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island		$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands			Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate Costs
Relocations		$	14,000,000
	SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	138,866,400
Real Estate		$	80,577,000
	SUBTOTAL	$	733,763,400
Monitoring		$	7,337,634
Adaptive Management		$	22,012,902
	TOTAL IMPLEMENTATION COST	**$**	**763,113,936**
O&M - Structures	$ 5,164,478		
O&M - Implementation	$ -		
TOTAL O & M COST	**$ 5,164,478**		

Table E-36.
Framework 5610 Subprovince 4 – E2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Oyster Bayou Structure (weir)		$	400,000
Long Point Structure (weir)		$	300,000
Alkali Ditch Structure (weir)		$	800,000
Black Lake Bayou Structure (weir)		$	500,000
New Lock at GIWW		$	75,000,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Hwy 82 Causeway Weir		$	8,000,000
SUBTOTAL		$	285,798,000
Relocations		$	-
SUBTOTAL		$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	77,165,460
Real Estate		$	21,891,000
SUBTOTAL		$	384,854,460
Monitoring		$	3,848,545
Adaptive Management		$	11,545,634
TOTAL IMPLEMENTATION COST		**$**	**400,248,638**
O&M - Structures	$ 3,031,076		
O&M - Implementation	$ -		
TOTAL O & M COST	**$ 3,031,076**		

Table E-37.
Framework 5610
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 92,684,000	$ 933,360,000	$ 500,320,000	$ 285,798,000	$ 1,812,162,000
Continuing Construction Cost	$ 135,000,000	$ 1,377,600,000	$ -	$ -	$ 1,512,600,000
Real Estate	$ 187,794,000	$ 382,625,000	$ 80,577,000	$ 21,891,000	$ 672,887,000
Relocations	$ 6,028,000	$ 4,620,000	$ 14,000,000	$ -	$ 24,648,000
E&D / S&A	$ 63,102,240	$ 625,206,600	$ 138,866,400	$ 77,165,460	$ 904,340,700
Monitoring & Adaptive Management	$ 19,384,330	$ 132,936,464	$ 29,350,536	$ 15,394,178	$ 197,065,508
Total Construction	$ 503,992,570	$ 3,456,348,064	$ 763,113,936	$ 400,248,638	$ 5,123,703,208
Project Implementation Reports (GI)					$ 256,185,160
PED					$ 153,711,096
				Total Cost	$ 5,533,599,465
				Total Cost Rounded	$ 5,534,000,000
Annual Costs					
O&M - Structures	$ 416,236	$ 416,236	$ 5,164,478	$ 3,031,076	$ 9,028,026
O&M - Implementation	$ 15,742,500	$ 11,104,500	$ -	$ -	$ 26,847,000
Science Plan					$ 8,000,000
				Total Annual Cost	$ 43,875,026
				Total Annual Cost Rounded	$ 44,000,000

Table E-38.
Framework 5410 Subprovince 1 – M2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
SUBTOTAL		$	227,684,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study
Relocations		$	6,028,000
SUBTOTAL		$	233,712,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	63,102,240
Real Estate		$	187,794,000
SUBTOTAL		$	484,608,240
Monitoring		$	4,846,082
Adaptive Management		$	14,538,247
TOTAL IMPLEMENTATION COST		**$**	**503,992,570**
O&M - Structures	$ 416,236		
O&M - Implementation	$ 15,742,500		
TOTAL O & M COST	**$ 16,158,736**		

Table E-38.
Framework 5410 Subprovince 2 --M1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ des Allemands		$	34,700,000
des Allemands sediment enrichment		$	75,000,000
Sediment delivery via pipeline at Myrtle Grove		$	176,250,000
5,000 cfs diversion at Myrtle Grove		$	34,300,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
60,000 cfs diversion @ Ft. Jackson		$	16,800,000
Sediment delivery via pipeline @ Empire		$	166,250,000
Sediment delivery via pipeline @ Bastion Bay		$	123,750,000
Sediment delivery via pipeline @ Head of Passes		$	743,750,000
Marsh creation @ Marsh creation feasibility study sites		$	300,113,000
	SUBTOTAL	$	3,300,973,000
Relocations		$	950,000
	SUBTOTAL	$	3,301,923,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	891,519,210
Real Estate		$	312,837,000
	SUBTOTAL	$	4,506,279,210
Monitoring		$	45,062,792
Adaptive Management		$	135,188,376
	TOTAL IMPLEMENTATION COST	**$**	**4,686,530,378**
O&M – Structures	$ 268,623		
O&M – Implementation	$ 12,678,000		
TOTAL O & M COST	**$ 12,946,623**		

Table E-38.
Framework 5410 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
1,000 cfs pump @ Bayou Lafourche	$	90,000,000
Northern Terrebonne marshes		
Avoca Island Levee Diversion	$	43,300,000
Repair GIWW banks	$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma	$	26,400,000
Channel Enlargement	$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou	$	18,500,000
Freshwater intro South of Lake Decade	$	2,200,000
Penchant Basin Plan	$	9,720,000
Relocate the navigation channel	$	93,000,000
Increase sediment transport down Wax Lake Outlet	$	16,800,000
Rebuild Historic Reefs – Pt. Au Fer to Eugene Island	$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island	$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou	$	8,100,000
SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands		Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock		Included in Real Estate Costs
Relocations	$	14,000,000
SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	138,866,400
Real Estate	$	80,577,000
SUBTOTAL	$	733,763,400
Monitoring	$	7,337,634
Adaptive Management	$	22,012,902
TOTAL IMPLEMENTATION COST	**$**	**763,113,936**

Table E-38.
Framework 5410 Subprovince 3 - R1 (continued).

O&M – Structures	$	5,164,478
O&M – Implementation	$	-
TOTAL O & M COST	**$**	**5,164,478**

Table E-38.
Framework 5410 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Oyster Bayou Structure (weir)		$	400,000
Long Point Structure (weir)		$	300,000
Alkali Ditch Structure (weir)		$	800,000
Black Lake Bayou Structure (weir)		$	500,000
New Lock at GIWW		$	75,000,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Hwy 82 Causeway Weir		$	8,000,000
	SUBTOTAL	$	285,798,000
Relocations		$	-
	SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	77,165,460
Real Estate		$	21,891,000
	SUBTOTAL	$	384,854,460
Monitoring		$	3,848,545
Adaptive Management		$	11,545,634
	TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-39.
Framework 5410
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 92,684,000	$ 2,098,373,000	$ 500,320,000	$ 285,798,000	$ 2,977,175,000
Continuing Construction Cost	$ 135,000,000	$ 1,202,600,000	$ -	$ -	$ 1,337,600,000
Real Estate	$ 187,794,000	$ 312,837,000	$ 80,577,000	$ 21,891,000	$ 603,099,000
Relocations	$ 6,028,000	$ 950,000	$ 14,000,000	$ -	$ 20,978,000
E&D / S&A	$ 63,102,240	$ 891,519,210	$ 138,866,400	$ 77,165,460	$ 1,170,653,310
Monitoring & Adaptive Management	$ 19,384,330	$ 180,251,168	$ 29,350,536	$ 15,394,178	$ 244,380,212
Total Construction	$ 503,992,570	$ 4,686,530,378	$ 763,113,936	$ 400,248,638	$ 6,353,885,522
Project Implementation Reports (GI)					$ 317,694,276
PED					$ 190,616,566
				Total Cost	$ 6,862,196,364
				Total Cost Rounded	$ 6,862,000,000
Annual Costs					
O&M - Structures	$ 416,236	$ 268,623	$ 5,164,478	$ 3,031,076	$ 8,880,413
O&M - Implementation	$ 15,742,500	$ 12,678,000	$ -	$ -	$ -
Science Plan					$ 8,000,000
				Total Annual Cost	$ 16,880,413
				Total Annual Cost Rounded	$ 17,000,000

Table E-40.
Framework 7610 Subprovince 1 -- E1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
5,000 cfs diversion @ Convent / Blind River.				42,700,000
Sediment delivery via pipeline @ Labranche Wetlands			$	138,750,000
10,000 cfs diversion @ Bonnet Carrie spillway			$	141,600,000
Sediment delivery via pipeline @ Central Wetlands			$	151,250,000
Sediment delivery via pipeline @ Golden Triangle Area			$	138,750,000
6,000 cfs diversion @ White's Ditch			$	20,700,000
Sediment delivery via pipeline @ American / California Bay			$	363,750,000
Sediment delivery via pipeline @ Quarantine Bay			$	338,750,000
Sediment delivery via pipeline @ Fort St. Phillip			$	158,750,000
15,000 cfs diversion @ American / California Bay			$	5,000,000
15,000 cfs diversion @ Fort St. Phillip			$	4,800,000
		SUBTOTAL	$	1,504,800,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study				Recommended Study
Relocations			$	3,230,000
		SUBTOTAL	$	1,508,030,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	407,168,100
Real Estate			$	171,228,000
		SUBTOTAL	$	2,086,426,100
Monitoring			$	20,864,261
Adaptive Management			$	62,592,783
		TOTAL IMPLEMENTATION COST	**$**	**2,169,883,144**
O&M – Structures	$	525,346		
O&M – Implementation	$	8,364,000		
TOTAL O & M COST	**$**	**8,889,346**		

Table E-40.
Framework 7610 Subprovince 2 --M3
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
1,000 cfs diversion @ des Allemands	$	17,000,000
1,000 cfs diversion @ Donaldsonville	$	14,500,000
1,000 cfs diversion @ Pikes Peak	$	11,800,000
1,000 cfs diversion @ Edgard	$	13,100,000
75,000 cfs diversion @ Myrtle Grove	$	357,700,000
Sediment Enrichment at Myrtle Grove	$	250,000,000
60,000 cfs diversion @ Fort Jackson	$	16,800,000
Barrier Island restoration at Barataria Shoreline.	$	502,460,000
Barrier Island Renourishment	$	1,127,600,000
SUBTOTAL	$	2,310,960,000
Relocations	$	4,620,000
SUBTOTAL	$	2,315,580,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	625,206,600
Real Estate	$	382,625,000
SUBTOTAL	$	3,323,411,600
Monitoring	$	33,234,116
Adaptive Management	$	99,702,348
TOTAL IMPLEMENTATION COST	**$**	**3,456,348,064**

O&M - Structures	$	724,406
O&M - Implementation	$	11,104,500
TOTAL O & M COST	**$**	**11,828,906**

Table E-40.
Framework 7610 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
1,000 cfs pump @ Bayou Lafourche			$	90,000,000
Northern Terrebonne marshes				
Avoca Island Levee Diversion			$	43,300,000
Repair GIWW banks			$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma			$	26,400,000
Channel Enlargement			$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou			$	18,500,000
Freshwater intro South of Lake Decade			$	2,200,000
Penchant Basin Plan			$	9,720,000
Relocate the navigation channel			$	93,000,000
Increase sediment transport down Wax Lake Outlet			$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island			$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island			$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou			$	8,100,000
		SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands			Recommended Study	
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate Costs	
Relocations			$	14,000,000
		SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	138,866,400
Real Estate			$	80,577,000
		SUBTOTAL	$	733,763,400
Monitoring			$	7,337,634
Adaptive Management			$	22,012,902
TOTAL IMPLEMENTATION COST			**$**	**763,113,936**
O&M – Structures	$	5,164,478		
O&M – Implementation	$	-		
TOTAL O & M COST	**$**	**5,164,478**		

Table E-40.
Framework 7610 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine HR	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-41.
Framework 7610
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 1,504,800,000	$ 933,360,000	$ 500,320,000	$ 285,798,000	$ 3,224,278,000
Continuing Construction Cost	$ -	$ 1,377,600,000	$ -	$ -	$ 1,377,600,000
Real Estate	$ 171,228,000	$ 382,625,000	$ 80,577,000	$ 21,891,000	$ 656,321,000
Relocations	$ 3,230,000	$ 4,620,000	$ 14,000,000	$ -	$ 21,850,000
E&D / S&A	$ 407,168,100	$ 625,206,600	$ 138,866,400	$ 77,165,460	$ 1,248,406,560
Monitoring & Adaptive Management	$ 83,457,044	$ 132,936,464	$ 29,350,536	$ 15,394,178	$ 261,138,222
Total Construction	$ 2,169,883,144	$ 3,456,348,064	$ 763,113,936	$ 400,248,638	$ 6,789,593,782
Project Implementation Reports (GI)					$ 339,479,689
PED					$ 203,687,813
				Total Cost	$ 7,332,761,285
				Total Cost Rounded	$ 7,333,000,000
Annual Costs					
O&M - Structures	$ 525,346	$ 724,406	$ 5,164,478	$ 3,031,076	$ 9,445,306
O&M - Implementation	$ 8,364,000	$ 11,104,500	$ -	$ -	$ 19,468,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 36,913,806
				Total Annual Cost Rounded	$ 37,000,000

Table E-42.
Framework 7002 Subprovince 1 – E1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
5,000 cfs diversion @ Convent / Blind River.			$	42,700,000
Sediment delivery via pipeline @ Labranche Wetlands			$	138,750,000
10,000 cfs diversion @ Bonnet Carrie spillway			$	141,600,000
Sediment delivery via pipeline @ Central Wetlands			$	151,250,000
Sediment delivery via pipeline @ Golden Triangle Area			$	138,750,000
6,000 cfs diversion @ White's Ditch			$	20,700,000
Sediment delivery via pipeline @ American / California Bay			$	363,750,000
Sediment delivery via pipeline @ Quarantine Bay			$	338,750,000
Sediment delivery via pipeline @ Fort St. Phillip			$	158,750,000
15,000 cfs diversion @ American / California Bay			$	5,000,000
15,000 cfs diversion @ Fort St. Phillip			$	4,800,000
SUBTOTAL			$	1,504,800,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study				Recommended Study
Relocations			$	3,230,000
SUBTOTAL			$	1,508,030,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	407,168,100
Real Estate			$	171,228,000
SUBTOTAL			$	2,086,426,100
Monitoring			$	20,864,261
Adaptive Management			$	62,592,783
TOTAL IMPLEMENTATION COST			**$**	**2,169,883,144**
O&M - Structures	$	525,346		
O&M - Implementation	$	8,364,000		
TOTAL O & M COST	**$**	**8,889,346**		

Table E-42.
Framework 7002 Subprovince 2 --E3
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ des Allemands w/sediment enrichment		$	34,700,000
des Allemands sediment enrichment		$	75,000,000
Mississippi River Third Delta (Subprovinces 2 & 3)		$	3,505,000,000
Mississippi River Third Delta sediment enrichment		$	250,000,000
Marsh creation @ Marsh creation feasibility study sites		$	300,113,000
90,000 cfs diversion @ Fort Jackson		$	21,300,000
Fort Jackson sediment enrichment		$	135,000,000
Relocation of Deep Draft Navigation Channel		$	1,115,000,000
Barrier Island restoration @ Barataria Shoreline (3,000')		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
	SUBTOTAL	$	7,066,173,000
Mississippi River Third Delta			Cost to be verified in recommended study
Relocation of Deep Draft Navigation Channel			Cost to be verified in recommended study
Relocations		$	92,550,000
	SUBTOTAL	$	7,158,723,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	1,932,855,210
Real Estate		$	343,688,000
	SUBTOTAL	$	9,435,266,210
Monitoring		$	94,352,662
Adaptive Management		$	283,057,986
	TOTAL IMPLEMENTATION COST	**$**	**9,812,676,858**
O&M - Structures	$ 7,964,363		
O&M - Implementation	$ 21,520,500		
TOTAL O & M COST	**$ 29,484,863**		

Table E-42.
Framework 7002 Subprovince 3 - M1
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Mississippi River Third Delta (Subprovinces 2 & 3)		See Costs for Framework S3 M1
Mississippi River Third Delta sediment enrichment		See Costs for Framework S3 M1
1,000 cfs pump @ Bayou Lafourche	$	90,000,000
Relocate the navigation channel	$	93,000,000
Increase sediment transport down Wax Lake Outlet	$	16,800,000
Rebuild historic barrier between Point Au Fer and Eugene Island	$	32,800,000
Rebuild Historic Reefs along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west	$	97,000,000
Northern Terrebonne marshes		
Avoca Island Levee Diversion	$	43,300,000
Repair GIWW banks	$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma	$	26,400,000
Channel Enlargement	$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou	$	18,500,000
Freshwater intro South of Lake Decade	$	2,200,000
Penchant Basin Plan	$	9,720,000
Stabilize banks of Southwest Pass	$	218,000,000
Maintain northern shorelines of East Cote Blanche Bay	$	9,100,000
Rebuild Historic Pointe Chevreuil Reef toward Marsh Island	$	76,600,000
Rehabilitate Terrebonne barrier islands	$	232,800,000
Renourish Terrebonne Barrier Islands	$	499,500,000
Rehabilitate northern shorelines of Terrebonne/Timbalier Bays	$	39,000,000
Backfill pipeline canals	$	179,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou	$	8,100,000
Maintain the land bridge between Caillou Lake and the gulf	$	41,000,000
Stabilize gulf shoreline	$	32,000,000
Maintain Timbalier land bridge	$	581,000,000
SUBTOTAL	$	2,408,320,000
Mississippi River Third Delta		Cost to be verified through additional study
Study the modification of the Old River Control Structure (ORCS) Operational Scheme to Benefit Coastal Wetlands		Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock		Included in Real Estate cost
Relocations	$	14,000,000
SUBTOTAL	$	2,422,320,000

Table E-42.
Framework 7002 Subprovince 3 - M1 (continued).

Engineering & Design (E&D) / Supervision & Administration (S&A)			$	654,026,400
Real Estate			$	171,883,000
SUBTOTAL			$	3,248,229,400
Monitoring			$	32,482,294
Adaptive Management			$	97,446,882
TOTAL IMPLEMENTATION COST			**$**	**3,378,158,576**
O&M - Structures	$	10,751,617		
O&M - Implementation	$	-		
TOTAL O & M COST	**$**	**10,751,617**		

Table E-42.
Framework 7002 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Oyster Bayou Structure (weir)		$	400,000
Long Point Structure (weir)		$	300,000
Alkali Ditch Structure (weir)		$	800,000
Black Lake Bayou Structure (weir)		$	500,000
New Lock at GIWW		$	75,000,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Hwy 82 Causeway Weir		$	8,000,000
	SUBTOTAL	$	285,798,000
Relocations		$	-
	SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	77,165,460
Real Estate		$	21,891,000
	SUBTOTAL	$	384,854,460
Monitoring		$	3,848,545
Adaptive Management		$	11,545,634
	TOTAL IMPLEMENTATION COST	**$**	**400,248,638**
O&M – Structures	$ 3,031,076		
O&M – Implementation	$ -		
TOTAL O & M COST	**$ 3,031,076**		

Table E-43.
Framework 7002
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 1,504,800,000	$ 5,478,573,000	$ 1,908,820,000	$ 285,798,000	$ 9,177,991,000
Continuing Construction Cost	$ -	$ 1,587,600,000	$ 499,500,000	$ -	$ 2,087,100,000
Real Estate	$ 171,228,000	$ 343,688,000	$ 171,883,000	$ 21,891,000	$ 708,690,000
Relocations	$ 3,230,000	$ 92,550,000	$ 14,000,000	$ -	$ 109,780,000
E&D / S&A	$ 407,168,100	$ 1,932,855,210	$ 654,026,400	$ 77,165,460	$ 3,071,215,170
Monitoring & Adaptive Management	$ 83,457,044	$ 377,410,648	$ 129,929,176	$ 15,394,178	$ 606,191,047
Total Construction	$ 2,169,883,144	$ 9,812,676,858	$ 3,378,158,576	$ 400,248,638	$ 15,760,967,217
Project Implementation Reports (GI)					$ 788,048,361
PED					$ 472,829,017
				Total Cost	$ 17,021,844,594
				Total Cost Rounded	$ 17,022,000,000
Annual Costs					
O&M - Structures	$ 525,346	$ 7,964,363	$ 10,751,617	$ 3,031,076	$ 22,272,402
O&M - Implementation	$ 8,364,000	$ 21,520,500	$ -	$ -	$ 29,884,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 60,156,902
				Total Annual Cost Rounded	$ 60,000,000

Table E-44.
Subprovince 1 – Modified Supplemental Framework 10130 (M2 modified)
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
Amite River diversion (spoil banks gapping)		$	2,855,000
Sediment delivery via pipeline at Labranche Wetlands		$	138,750,000
Rehab. Violet Siphon proj. for enhanced influence in Central Wetlands		$	11,800,000
Marsh nourishment on land bridge separating L. Pontchartrain and L. Borgne		$	71,100,000
	SUBTOTAL	$	452,189,000
Divert water from IHNC to Central Wetlands			Addressed under separate authority
Caernarvon - optimize for marsh creation (reauthorization project)			To Be Identified by Additional Study
MRGO include environmental restoration / Seabrook control struc.			Recommended Study
Bonne Carre - opportunistic use			Authorized under CWPPRA
Relocations		$	6,028,000
	SUBTOTAL	$	458,217,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	123,718,590
Real Estate		$	201,813,000
	SUBTOTAL	$	783,748,590
Monitoring		$	7,837,486
Adaptive Management		$	23,512,458
	TOTAL IMPLEMENTATION COST	**$**	**815,098,534**
O&M - Structures	$ 516,200		
O&M - Implementation	$ 15,742,500		
TOTAL O & M COST	**$ 16,258,700**		

Table E-44.
Subprovince 2 -- Modified Supplemental Framework 10130 (R1)
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)	
IMPLEMENTATION COSTS			
1,000 cfs diversion at Lac des Allemands		$	17,000,000
1,000 cfs diversion at Donaldsonville		$	14,500,000
1,000 cfs diversion at Pikes Peak		$	11,800,000
1,000 cfs diversion at Edgard		$	13,100,000
Sediment delivery via pipeline at Myrtle Grove		$	112,000,000
Myrtle Grove diversion 5,000 cfs		$	34,300,000
60,000 cfs diversion @ Boothville		$	16,800,000
Boothville Sediment Enrichment		$	122,700,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
Marsh Creation Study Sites		$	300,113,000
	SUBTOTAL	$	2,272,373,000
Reauthorization of Davis Pond		To Be Identified by Additional Study	
Mississippi River Delta Management Study		Recommended Study	
Third Delta (recognize as part of national LCA plan, critical to attaining restoration scales, but too early to include in evaluation of this plan)		Recommended Study	
Relocations		$	4,260,000
	SUBTOTAL	$	2,276,633,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	614,690,910
Real Estate		$	267,754,000
	SUBTOTAL	$	3,159,077,910
Monitoring		$	31,590,779
Adaptive Management		$	94,772,337
	TOTAL IMPLEMENTATION COST	**$**	**3,285,441,026**
O&M – Structures	$ 844,689		
O&M - Implementation	$ 12,678,000		
TOTAL O & M COST	**$ 13,522,689**		

Table E-44.
Subprovince 3 – Modified Supplemental Framework 10130 (R1 modified)
Cost Estimates.

Item		Cost ($)	
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Penchant Basin Plan		$	9,720,000
Maintain Northern Shore of Cote Blanche Bay at Pointe Marone		$	9,100,000
Rebuild Historic Pointe Chevreuil Reef toward Marsh Island		$	76,600,000
Restore Terrebonne Barrier Islands		$	232,800,000
Renourish Terrebonne Barrier Islands		$	499,500,000
Maintain Land Bridge between Sister Lake & Gulf of Mexico		$	41,000,000
Stabilize Gulf Shoreline at Pointe Au Fer Island		$	32,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	1,259,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands		Recommended Study	
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate Costs
Relocations		$	14,000,000
	SUBTOTAL	$	1,273,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	343,796,400
Real Estate		$	88,097,000
	SUBTOTAL	$	1,705,213,400
Monitoring		$	17,052,134
Adaptive Management		$	51,156,402
TOTAL IMPLEMENTATION COST		**$**	**1,773,421,936**
O&M - Structures	$ 4,577,325		
O&M - Implementation	$ -		
TOTAL O & M COST	**$ 4,577,325**		

Table E-44.
Subprovince 4 - Modified Supplemental Framework 10130 (E2 modified)
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Salinity Control at Oyster Bayou Structure		$	400,000
Salinity Control at Long Point Structure		$	300,000
Salinity Control at Alkali Ditch Structure		$	800,000
Salinity Control at Black Lake Bayou Structure		$	500,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Causeway Weir		$	8,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Black Bayou Culvert Freshwater Introduction		$	5,600,000
	SUBTOTAL	$	216,398,000
Chenier Plain Freshwater Management and Allocation Reassessment			Recommended Study
Relocations		$	-
	SUBTOTAL	$	216,398,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	58,427,460
Real Estate		$	21,794,000
	SUBTOTAL	$	296,619,460
Monitoring		$	2,966,195
Adaptive Management		$	8,898,584
	TOTAL IMPLEMENTATION COST	**$**	**308,484,238**
O&M - Structures	$ 1,960,233		
O&M - Implementation	$ -		
TOTAL O&M COST	**$ 1,960,233**		

Table E-45.
Modified Supplemental Framework 10130
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 317,189,000	$ 1,022,073,000	$ 759,820,000	$ 216,398,000	$ 2,315,480,000
Continuing Construction Cost	$ 135,000,000	$ 1,250,300,000	$ 499,500,000	$ -	$ 1,884,800,000
Real Estate	$ 201,813,000	$ 267,754,000	$ 88,097,000	$ 21,794,000	$ 579,458,000
Relocations	$ 6,028,000	$ 4,260,000	$ 14,000,000	$ -	$ 24,288,000
E&D / S&A	$ 123,718,590	$ 614,690,910	$ 343,796,400	$ 58,427,460	$ 1,140,633,360
Monitoring & Adaptive Management	$ 31,349,944	$ 126,363,116	$ 68,208,536	$ 11,864,778	$ 237,786,374
Total Construction	$ 815,098,534	$ 3,285,441,026	$ 1,773,421,936	$ 308,484,238	$ 6,182,445,734
Project Implementation Reports (GI)					$ 309,122,287
PED					$ 185,473,372
				Total Cost	$ 6,677,041,393
				Total Cost Rounded	$ 6,677,000,000
Annual Costs					
O&M - Structures	$ 516,200	$ 844,689	$ 4,577,325	$ 1,960,233	$ 7,898,447
O&M - Implementation	$ 15,742,500	$ 12,678,000	$ -	$ -	$ 28,420,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 44,318,947
				Total Annual Cost Rounded	$ 44,000,000

7.0 DEVELOPMENT OF LCA RESTORATION PLAN: RATIONAL FOR DEVELOPING THE LCA RESTORATION PLAN FROM THE ARRAY OF COASTWIDE FRAMEWORK PROJECT FEATURES (PHASE VI)

Upon the completion of Phase V efforts, with attention to the science and technology (S&T) uncertainties and model uncertainties, the PDT redirected the plan formulation effort towards definition of a plan that focused on critical restoration efforts in the near-term, the next 5 to 10 years. The PDT determined that a LCA Plan would best meet the overall study objectives through inclusion of several complementary plan components that differ in scale and time. These would include:

- Near-term, highly certain feature concepts for development and implementation;
- Identified, feature-related uncertainties and potential methods or features to resolve them; and
- Large-scale and long-range feature concepts to be more fully developed.

Having identified the most efficient, effective, and complete combinations, the features within the final array of coast wide frameworks were used as the starting point for the identification of alternative LCA Plans. These 79 restoration features that were combined into the coast wide frameworks of the final array primarily addressed areas of critical wetland loss, opportunities for the reestablishment of deltaic processes, and the protection and restoration of geomorphic features. The 79 features were the building blocks for alternative LCA Plans in Phase VI.

7.1 Description of the restoration features identified in the Final Array of Coast wide Frameworks

The PDT determined that the follow-on feasibility study process would analyze and optimize specific locations and dimensions for any restoration feature that would ultimately become a component of the LCA Plan that best met the objectives. Instead, general details about restoration features were included as part of this plan formulation process. For example, diversions were referred to as either small, medium, or large, where small equates to 1,000-5,000 cfs diversions, medium to 5,000-15,000 cfs diversions, and large to greater than 15,000 cfs diversions. More detailed cost information regarding the features is available at the District upon request. The features are shown on **figures MR-31** through **MR-34** of the main report.

7.1.1 Subprovince 1 feature descriptions

<u>Medium diversion at American/California Bays</u>

This restoration feature provides for a medium non-structural, uncontrolled diversion from the Mississippi River at American/California Bays. The diversion feature would consist of an armored crevasse through the existing un-leveed riverbank into the fringe marsh and open water of the bay system. The objective of this feature is to increase sediment introduction into American/California Bays. The introduction of additional sediment would facilitate organic and mineral sediment deposition, improve biological productivity, and prevent further deterioration of the marshes.

<u>Medium to large sediment diversion at American/California Bays</u>

This restoration feature involves a large non-structural, uncontrolled sediment diversion from the Mississippi River with sediment enrichment at American/California Bays. The diversion feature would consist of an armored crevasse through the existing un-leveed riverbank into the fringe marsh and open water of the bay system. The objective of this feature is to maximize sediment inputs and spur large-scale land building in American/California Bays. This area was historically an outflow area of the Mississippi River, which received river discharges during flooding events. The creation and restoration of wetlands in American/California Bays would have the added benefit of stabilizing the Breton Sound marshes to the north by reducing marine influences from the Gulf of Mexico.

<u>Rehabilitate Bayou Lamoque structure as a medium diversion</u>

This feature provides for the refurbishment and operation of a pair of diversion structures, regulating the flow of Mississippi River water into Bayou Lamoque, a former distributary of the Mississippi River. The existing Bayou Lamoque diversion structures require mechanical rehabilitation and operational security modifications. The remote location of these structures and the frequent occurrence of vandalism have resulted in an inability to ensure consistent and reliable operation. The objective of this feature is to increase and maintain riverine inflows into Bayou Lamoque. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse.

<u>Medium diversion at Bonnet Carre Spillway</u>

This restoration feature would be located at the existing Bonnet Carre Spillway and involve a reevaluation of the existing authorized project. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carre Spillway into Lake Pontchartrain. The restoration feature consists of a medium diversion with east and west branches into the La Branche wetlands and Manchac land bridge - diverted through a modified segment of the existing flood control structure and redirected through the guide levees into adjacent wetlands. The objective of the project is to decrease salinities in Lake Pontchartrain and the surrounding marshes, especially the La Branche Wetlands, and to add nutrients and some sediment to these marshes and swamps. This feature is located in the vicinity of a historic crevasse.

Small diversion at Convent/Blind River

This restoration feature involves a small diversion from the Mississippi River into Blind River through a new control structure. The objective of this feature is to introduce sediments and nutrients into the southeast portion of Maurepas Swamp. This feature is intended to operate in conjunction with the Hope Canal diversion to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

Medium diversion at Fort St. Philip

This restoration feature provides for a medium diversion from the Mississippi River into marshes northeast of Fort St. Philip, between the Mississippi River and Breton Sound. Objectives of this feature are to reduce wetland loss and facilitate riverine influences to these marshes. The diversion would facilitate organic deposition in and biological productivity of the marshes by increasing freshwater circulation and providing sediments and nutrients to the system.

Small diversion at Hope Canal (CWPPRA Maurepas diversion)

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Hope Canal. The objective is to introduce sediments and nutrients into Maurepas Swamp south of Lake Maurepas. The introduction of additional freshwater via the diversion would facilitate organic deposition, improve biological productivity, and prevent further deterioration of the swamp. Work for this feature has been initiated in engineering and design and NEPA compliance under CWPPRA.

Medium diversion at White's Ditch

This restoration feature, located at White's Ditch, downstream of the Caernarvon diversion structure, provides for a medium diversion from the Mississippi River into the central River aux Chenes area using a controlled structure. The objective of the feature is to provide additional freshwater, nutrients, and fine sediments to the area between the Mississippi River and River aux Chenes ridges. This area is currently isolated from the beneficial effects of the Caernarvon freshwater diversion. The introduction of additional freshwater would facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at American/California Bays

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet) open water in this bay system requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the American/California Bays.

Sediment delivery via pipeline at Central Wetlands

This restoration feature provides for placement of sediment mined from the Mississippi River into the Central Wetlands adjacent to the MRGO and Violet canal, via pipeline. The objective of this feature is to enhance and create wetlands by placing dredged sediments in the shallow (1 to 2 feet) open waters of the marshes. Placement of this dredged material would counteract marsh breakup by providing sediment and nutrients to renourish the area. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Fort St. Philip

This feature provides for sediment delivery at Fort St. Philip via programmatic sediment mining from the Mississippi River. The objective of the feature is to create and/or restore marsh habitat by depositing sediment in appropriate moderately shallow (3 to 5 feet) open water areas in the vicinity of Fort St. Philip. Enhancement of these marshes would facilitate biological productivity of the marshes and reduce wetland loss.

Sediment delivery via pipeline at Golden Triangle

This restoration feature provides for sediment delivery via sediment mined from the Mississippi River and placed in the area formed by the confluence of the MRGO, GIWW, and Lake Borgne. The objective of the feature is to create and/or restore marsh habitat by depositing sediment in appropriate shallow (1 to 2 feet) open water in the area adjacent to these three water bodies. Enhancement of these marshes would facilitate biological productivity of the marshes and reduce wetland loss.

Sediment delivery via pipeline at La Branche Wetlands

The proposed restoration feature includes the dedicated dredging of sediment from the Mississippi River, which would be delivered via pipeline to shallow (1 to 2 feet) open waters within the La Branche Wetlands in the southwest corner of Lake Pontchartrain. The creation and restoration of these marshes would facilitate improved biological productivity and reduce wetland loss. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Quarantine Bay

This restoration feature provides for sediment delivery to Quarantine Bay via programmatic sediment mining from the Mississippi River. The objective of the feature would be to create wetland habitat through the placement of dredge sediments in the moderately shallow (3 to 5 feet) open waters of Quarantine Bay.

Opportunistic use of Bonnet Carre Spillway (CWPPRA project)

This restoration feature involves freshwater introductions from the Mississippi River via the opportunistic use of the existing flood control structure at the Bonnet Carre Spillway. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carre Spillway into Lake Pontchartrain. This feature would allow for freshwater introductions to be delivered to Lake Pontchartrain and the adjacent La Branche wetlands during times of high river water levels. Thus, the river introductions would help reduce salinities in the southwest corner of Lake Pontchartrain and nourish the intermediate and brackish marshes in La Branche with sediment and nutrients. This feature is located in the vicinity of a historic crevasse.

Increase Amite River Diversion Canal influence by gapping banks

This restoration feature involves the construction of gaps in the existing dredged material banks of the Amite River Diversion Canal. The objective of this feature is to allow floodwaters to introduce additional nutrients and sediment into western Maurepas Swamp. The exchange of flow would occur during flood events on the river and from the runoff of localized rainfall events. This feature would provide nutrients and sediment to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

Marsh nourishment on New Orleans East land bridge

This restoration feature involves wetland creation through the dedicated dredging of sediments from lake bottom sources. The objective of this feature is to create wetlands by placing dredged sediments in the shallow open waters within the land bridge separating Lakes Pontchartrain and Borgne. This area has experienced wetland deterioration and loss due to erosion from wave energies in Lake Borgne. Reinforcing the land bridge between the two lakes would help maintain the salinity gradients in Lake Pontchartrain and ensure the long-term sustainability of the wetland ecosystems in the area.

Mississippi River Delta Management Study

This restoration concept requires detailed investigations to address the maximization of river resources, such as excess freshwater and sediments, for wetland restoration. The objective of this concept is to greatly increase the deposition of Mississippi River sediments on the shallow continental shelf, while ensuring navigation interests. Sediment, nutrients, and freshwater would be re-directed to restore the quality and sustainability of the Mississippi River Deltaic Plain, its coastal wetland complex, and the Gulf of Mexico. The study would investigate potential modifications to existing navigation channel alignments and maintenance procedures and requirements.

Mississippi River Gulf Outlet (MRGO) environmental restoration features

This restoration opportunity involves the implementation of the environmental restoration features under consideration by the MRGO Environmental Restoration Study. In response to public concerns, adverse environmental effects, and national economic development considerations, an ongoing study is re-evaluating the viability of operation and maintenance of this authorized navigation channel. Since the construction of the MRGO, saltwater intrusion and boat wake erosion have degraded large expanses of freshwater marshes and accelerated habitat switching from freshwater marshes to brackish and intermediate marshes in the Biloxi marshes, the Central Wetlands, and the Golden Triangle wetlands. This environmental restoration study would evaluate the stabilization of the MRGO banks and various environmental restoration projects, including evaluation of freshwater reintroductions into the Central Wetlands and possible channel depth modification. Implementation of this feature would result in hydrologic restoration.

Modification of Caernarvon diversion

The Caernarvon diversion structure, constructed on the Mississippi River in 1992 near the Breton Sound marshes, has a maximum operating capacity of 8,000 cfs. The structure has been operated as a salinity management feature, with freshwater introductions ranging between 1,000 cfs to 6,000 cfs, but in general averaging something less than half of the structure's capacity. The primary purpose of the existing Caernarvon project has been to maintain salinity gradients in the central portion of Breton Sound. This operation, in effect, partially restored the historic functions of marsh nourishment (e.g., freshwater inflow, providing nutrients and sediment to the marsh, and countering the effects of subsidence). The proposed restoration feature would seek an authorization change of the Caernarvon project purpose to include wetland creation and restoration, thereby altering the project's operational plan. This would allow an increase in the freshwater introduction rate, perhaps 5,000 cfs on average, to accommodate the wetland building function of the system. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse.

<u>Rehabilitate Violet Siphon for enhanced influence to Central Wetlands</u>

This restoration feature involves the rehabilitation of the existing Violet Siphon water control structure, which is located between the Mississippi River and the MRGO, in the Central Wetlands. The objectives of this feature are to improve the operation of the Violet Siphon and enhance freshwater flows into the Central Wetlands. This action would increase freshwater in the wetlands and nourish the remaining swamp and intermediate marshes. The success of this feature would be enhanced with the freshwater introductions via the IHNC lock feature. This feature is located in the vicinity of a historic crevasse.

<u>Post authorization change for the diversion of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands</u>

This restoration feature calls for a post-authorization modification of the IHNC lock. Modifications would incorporate culverts and controls to divert freshwater from the Mississippi River through the IHNC to the Central Wetlands. The objectives of this feature are to introduce freshwater and nutrients into the intermediate and brackish marshes of the Central Wetlands, boost plant productivity, and reduce elevated salinities. This restoration feature could also enhance the effect of the Violet Siphon structure rehabilitation restoration feature.

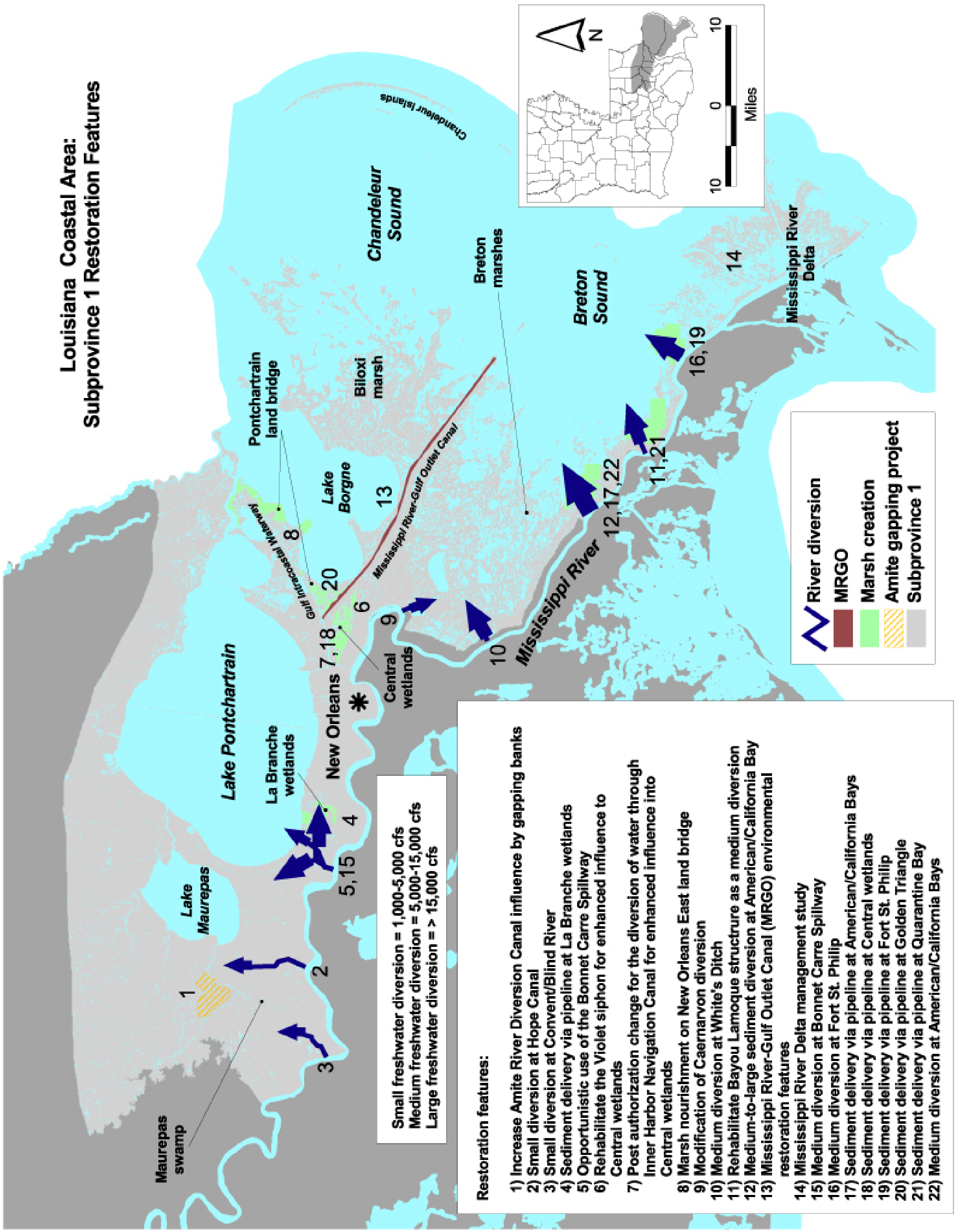


Figure E-46. Subprovince 1 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

7.1.2 Subprovince 2 Feature Descriptions

Large diversion at Boothville with sediment enrichment

This restoration feature provides for a large nonstructural, uncontrolled sediment diversion from the Mississippi River near Boothville into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediments in the moderately deep (6 to 10 feet) open waters of Yellow Cotton / Hospital Bays. The freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. Ultimately, sediments would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. Sediment enrichment assumes use of 20-inch dredge at capacity for three months yielding 1,468,000 yd^3 each year. The diversion would maximize sediment and nutrient inputs and spur large-scale land building in the extreme southeastern portion of Barataria Bay.

Small diversion at Donaldsonville

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Donaldsonville. The objective is to introduce freshwater, sediments, and nutrients into upper Bayou Verret, which is located to the northwest of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forests. This feature is intended to operate in conjunction with three other small diversions in the area.

Small diversion at Edgard

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Edgard. The objective is to introduce freshwater, sediments, and nutrients into Bayou Fortier, which is located to the northeast of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forest. This feature is intended to operate in conjunction with three other small diversions in the area.

Medium diversion at Edgard with sediment enrichment

This restoration feature involves a medium diversion from the Mississippi River through a new control structure at Edgard. The objective is to introduce freshwater, sediments, and nutrients into Bayou Fortier, which is located to the northeast of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forest. Sediment enrichment would involve use of 12-inch dredge for three months. Discharge of effluent upstream of the diversion intake would allow the capture of silts and very fine sands only.

Medium diversion at Fort Jackson - Alternative to Boothville diversion

This restoration feature provides for a medium non-structural, uncontrolled sediment diversion from the Mississippi River near Fort Jackson into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediments in the moderately deep (6 to 10 feet) open waters of Yellow Cotton/Hospital Bays. The associated freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. The diversion would maximize sediment and nutrient inputs and spur land building in the extreme southeastern portion of Barataria Bay.

Large diversion at Fort Jackson with sediment enrichment - Alternative to Boothville diversion

This restoration feature provides for a large (50,000 to 100,000 cfs) non-structural, uncontrolled sediment diversion from the Mississippi River near Fort Jackson into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediments in the moderately deep (6 to 10 feet) open waters of Yellow Cotton / Hospital Bays. The associated freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. Sediment enrichment assumes use of 20-inch dredge at capacity for three months yielding 1,468,000 yd^3 each year. Ultimately, sediments would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. The diversion would maximize sediment and nutrient inputs and spur large-scale land building in the extreme southeastern portion of Barataria Bay.

Small diversion at Lac des Allemands

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Lac Des Allemands. The objective is to introduce freshwater, sediments, and nutrients into Bayou Becnel, which is located to the north of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in Bayou Becnel and surrounding Lac Des Allemands area is classified as wetland forest, consisting primarily of bottomland hardwood forest. This feature is intended to operate in conjunction with three other small diversions in the area.

Medium diversion at Lac des Allemands with sediment enrichment

This restoration feature involves a medium diversion from the Mississippi River through a new control structure at Lac Des Allemands. The objective is to introduce freshwater, sediments, and nutrients into Bayou Becnel, which is located to the north of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in Bayou Becnel and surrounding Lac Des Allemands area is classified as wetland forest, consisting primarily of bottomland hardwood forest. Sediment enrichment would involve use of 12-inch dredge for three months. Discharge of effluent upstream of the diversion intake would allow the capture of silts and very fine sands only. This feature is intended to operate in conjunction with three small diversions in the area.

Medium diversion with dedicated dredging at Myrtle Grove

This restoration feature involves a medium diversion of the Mississippi River near Myrtle Grove through a new control structure. The diversion would provide additional sediment and nutrients to nourish highly degraded existing fresh to brackish wetlands in shallow open water areas. This reintroduction would ensure the long-term sustainability of these marshes by increasing plant productivity, thereby preventing future loss. The introduction of sediment to this area would also promote the infilling of shallow open water areas both through deposition and marsh expansion. Dedicated dredging of sediment mined from the Mississippi River would complement this feature. This feature is located in the vicinity of a historic crevasse. Work has been initiated on engineering and design and NEPA compliance under CWPPRA.

Large diversion at Myrtle Grove with sediment enrichment

This restoration feature involves a large sediment diversion from the Mississippi River near Myrtle Grove through a new control structure. The diversion would provide additional sediment and nutrients to nourish highly degraded existing fresh to brackish wetlands in shallow open water areas throughout the central Barataria basin. This reintroduction would allow the creation of new wetland in expansive open water and bay areas and ensure the long-term sustainability of currently degraded marshes by increasing plant productivity, thereby preventing future loss. The additional introduction of sediment by enrichment assumes use of 30-inch dredge at capacity for three months yielding 6,293,000 yd^3 each year. This feature is located in the vicinity of a historic crevasse.

Small diversion at Pikes Peak

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Pikes Peak. The objective is to introduce freshwater, sediments and nutrients into Bayou Chevreuil, which is located to the north of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood wetlands. This feature is intended to operate in conjunction with three other small diversions in the area.

Barataria Basin barrier shoreline restoration

This restoration feature involves mining of offshore sediment sources to reestablish sustainable barrier islands. The feature is based on designs developed in the LCA Barataria Barrier Island Restoration study and assumes a 3,000-foot wide island footprint. The critical areas include the Caminada-Moreau Headland (an area between Belle Pass and Caminada Pass) and Shell Island (a barrier island in the Plaquemines barrier island system). These barrier shoreline segments are critical components of the Barataria shoreline. The Shell Island segment has been nearly lost and failure to take restorative action could result in the loss of any future options for restoration. This would result in permanent modification of the tidal hydrology of the Barataria Basin. The Caminada-Moreau Headland protects the highest concentration of near-gulf oil and gas infrastructure in the coastal zone. This reach of the Barataria shoreline also supports the only land-based access to the barrier shoreline in the Deltaic Plain.

Implement the LCA Barataria Basin Wetland Creation and Restoration Study

This feature involves implementation of components of the LCA Barataria Basin Wetland Creation and Restoration Study. The wetlands in the lower Barataria Basin have experienced wetland deterioration due to subsidence, a lack of circulation, saltwater intrusion, and a paucity of sediment and nutrients. Sediment dredged from offshore borrow sites would be placed at specific sites near Bayou Lafourche in the Caminada Headland to create and restore marsh and ridge habitat in the area.

Modification of Davis Pond diversion for increased sediment input

The Davis Pond diversion structure, constructed in 2002 in upper Barataria Basin, has a maximum operating capacity of 10,600 cfs. The structure has been operated as a salinity management feature, with freshwater introductions from the Mississippi River ranging from 1,000 cfs up to 5,000 cfs averaging, to this point in time, considerably less than half of the structure's capacity. The primary purpose of the existing Davis Pond project has been to maintain salinity gradients in the central portion of Barataria Basin. This operation, in effect, partially restored the historic functions of marsh nourishment (e.g., freshwater inflow, providing nutrients and sediment to the marsh, and countering the effects of subsidence). This restoration feature would seek an authorization change of the Davis Pond project purpose to include wetland creation and restoration, thereby altering the project's operational plan. This would allow an increase in the freshwater introduction rate, perhaps 5,000 cfs on average, to accommodate the wetland building function of the system. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Bastian Bay/Buras

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet) open water in this bay system requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the highly degraded Bastian Bay and Buras area.

Sediment delivery via pipeline at Empire

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet) open water in Bay Adams and Barataria Bay requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the highly degraded areas south and west of Empire.

Sediment delivery via pipeline at Main Pass (Head of Passes)

This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River utilizing a sediment trap above the Head of Passes. The estimated annual yield of dredge material from the sediment trap is 9 million cubic yards. The objective of this feature is to create wetlands in the degraded areas in the east and west portions of the Mississippi River Delta south of Venice.

Third Delta (Subprovinces 2 & 3)

This feature provides for a large diversion from the Mississippi River through a new control structure in the vicinity of Donaldsonville. This feature provides for an approximately 240,000 cfs diversion at maximum river stage. Flows would be diverted into a newly constructed conveyance channel (parallel to Bayou Lafourche) extending approximately 55 miles from the initial point of diversion to the eventual point of discharge. Diverted flow would be divided equally at a point north of the GIWW to enable the creation of a deltaic wetlands complex in each of the Barataria and Terrebonne Basins. A possible alternative configuration would involve a 120,000 cfs diversion at maximum river stage into the Barataria Basin only. Enrichment of this diversion would also be considered and assumes use of 30-inch dredge at capacity for three months yielding 6,293,000 yd^3 each year. The study requires significant investigations of flood control, drainage, and navigation impacts in addition to environmental and design efforts.

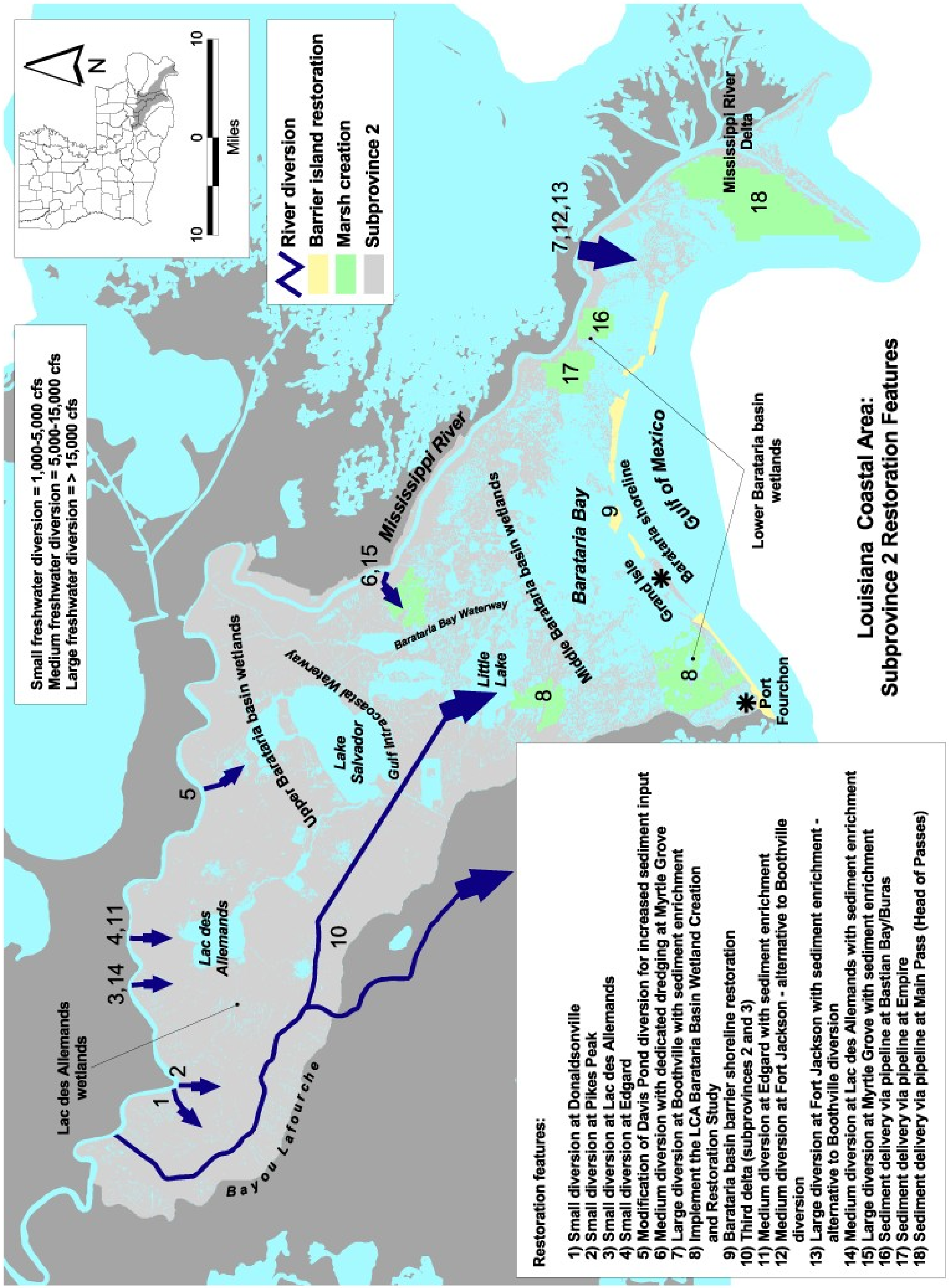


Figure E-47. Subprovince 2 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

7.1.3 Subprovince 3 feature descriptions

Backfill pipeline canals

This restoration feature provides for the backfilling of pipeline canals south of Catfish Lake. The Twin Pipeline canals in this area are crossed by numerous oilfield canals, which have greatly altering natural water circulation patterns. The 63,300 feet of pipeline canals would be filled at strategic locations to restore primary water circulation through Grand Bayou Blue. The retention time of Atchafalaya and Bayou Lafourche (pumped) flows would be increased to benefit affected wetlands.

Small Bayou Lafourche reintroduction

This restoration feature would reintroduce flow from the Mississippi River into Bayou Lafourche. The piped flow would be continuous and would freshen and reduce loss rates for the wetlands between Bayous Lafourche and Terrebonne, south of the GIWW.

Convey Atchafalaya River water to Terrebonne marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction/enlargement.

This restoration feature would enhance existing Atchafalaya River influence to central (Lake Boudreaux) and eastern (Grand Bayou) Terrebonne marshes via the GIWW by introducing flow into the Grand Bayou basin by enlarging the connecting channel (Bayou L'Eau Bleu) to capture as much of the surplus flow (max. 2000 to 4000 cfs) that would otherwise leave the Terrebonne Basin. Several alternatives would be evaluated through hydrologic models; however in all cases, gated control structures would be installed to restrict channel cross-section to prevent increased saltwater intrusion during the late summer and fall when riverine influence is typically low. Some alternatives may include auxiliary freshwater distribution structures. This feature also includes repairing banks along the GIWW and enlarging constrictions in the GIWW.

Freshwater introduction south of Lake De Cade

This restoration feature is intended to enhance Atchafalaya flows to Terrebonne wetlands between Lake De Cade, Bayou du Large, and Lake Mechant by constructing three small conveyance channels along the south shore of Lake De Cade to the Small Bayou La Pointe area. Channel flows would be controlled by structures that could be actively operated. Lowering salinities and increasing nutrient inputs would reduce intermediate marsh losses.

Freshwater introduction via Blue Hammock Bayou

This restoration feature would increase flow from the Atchafalaya River to the southwest Terrebonne wetlands by increasing the cross-section of Blue Hammock Bayou. This would increase the distribution of Atchafalaya flows from Four League Bay to the Lake Mechant wetlands. Grand Pass and Buckskin Bayou, outlets of Lake Mechant, would be reduced in cross section to increase the retention and benefits of Atchafalaya nutrients, sediment, and freshwater in these estuarine wetlands. Additional marsh would also be created with dredged material.

Increase sediment transport down Wax Lake Outlet

This restoration feature would increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet flows passes over the relatively shallow Six Mile Lake before entering the outlet. This restoration feature would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby increasing bed load sediments transported to the Wax Lake Outlet Delta.

Maintain land bridge between Caillou Lake and Gulf of Mexico

This restoration feature would maintain the land bridge between the gulf and Caillou Lake by placing shore protection in Grand Bayou du Large to minimize saltwater intrusion. This feature would involve rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou du Large, to prevent a new channel from breaching the bayou bank and allowing a new connection with Caillou Lake. Some gulf shore armoring would be needed to protect these features from erosion on the gulf shoreline. Gulf shoreline armoring might be required where shoreline retreat and loss of shoreline oyster reefs has allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Some newly opened channels would be closed to restore historic cross-sections of exchange points. By reducing marine influences in these interior areas, this feature would allow increased freshwater influence from Four League Bay to benefit area marshes.

Maintain land bridge between Bayous du Large and Grand Caillou

This restoration feature provides for construction of a land bridge between Bayous du Large and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses, a small human-made channel for navigation, has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining water bodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous berm of “high marsh” in the area. This berm would separate the higher, healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.

Maintain northern shore of East Cote Blanche Bay at Point Marone

This restoration feature would protect the north shore of East Cote Blanche Bay from Point Marone to Jackson Bayou. Bay shoreline would be stabilized to protect the interior wetland water circulation patterns in the Cote Blanche Wetlands CWPPRA project. The feature was designed to increase the retention time of the Atchafalaya flows moving from the GIWW to East Cote Blanche Bay.

Maintain Timbalier land bridge

This restoration feature provides for maintaining the Timbalier land bridge in the upper salt marsh zone. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining water bodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous berm of “high marsh” extending from Bayou Terrebonne to Bayou Lafourche. This berm would allow the freshwater flowing down from the GIWW through Grand Bayou to have a greater influence on interior marshes through existing water exchange points along Grand Bayou north of the proposed land bridge.

Multi-purpose operation of Houma Navigation Canal (HNC) Lock

The restoration feature involves the multi-purpose operation of the proposed HNC Lock, located at the southern end of the HNC. The Morganza to the Gulf Hurricane Protection Study includes construction of the lock, but does not include the multi-purpose operation of the lock. The objective of this feature is to make more efficient use of Atchafalaya River waters and sediment flow, as well as maintain salinity regimes favorable for area wetlands. The proposed structure would be operated to restrict saltwater intrusion and distribute freshwater and sediments during times of high Atchafalaya River flow. The current project is designed to limit saltwater intrusion, but with a minor modification would provide additional benefits to the wetlands by increasing retention time of Atchafalaya River water in the Terrebonne Basin wetlands. An increased retention time would provide additional sediment and nutrients to nourish the wetlands and would benefit the forested wetlands, and fresh, intermediate, and brackish marshes adjacent to the lock and canal; the Lake Boudreaux wetlands to the north; the Lake Mechant wetlands to the west; and the Grand Bayou wetlands to the east.

Optimize flows and Atchafalaya River influence in Penchant Basin

This restoration feature involves the implementation of the Penchant Basin Plan. This would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods, and reduce excessive water levels in the upper Penchant Subbasin. Increased outlet capacities would utilize flow, increasing circulation and retention in tidal wetlands below the large fresh floating marsh zone.

Rebuild Historic Reefs - rebuild historic barrier between Point Au Fer and Eugene Island and construct segmented reef/breakwater/jetty along the historic Point Au Fer Barrier Reef from Eugene Island extending towards Marsh Island to the west

This restoration feature would enhance Atchafalaya Delta growth and Atchafalaya River influence in Atchafalaya Bay, Point Au Fer Island, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene Island. This barrier would separate these areas from the gulf following the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the erosive wave effects. Atchafalaya River freshwater influence would be increased in the interior areas of the Atchafalaya Basin. Constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west would produce similar beneficial effects in the western portion of Atchafalaya Bay. The barrier would join the Bayou Sale natural levee feature.

Acadiana Bay estuarine restoration

This restoration feature provides for rebuilding historic Point Chevreuil Reef toward Marsh Island, and rehabilitating the Bayou Sale natural levee between Point Chevreuil and the gulf. The natural levee would be rebuilt in the form of a shallow sub-aqueous platform, small islands, and/or reefs. The historic shell reefs were removed by shell dredging. This feature was designed to help restore historic hydrologic conditions in the Teche/Vermilion Basin.

Rehabilitate northern shorelines of Terrebonne/Timbalier Bays

This feature provides for the rehabilitation of the northern shorelines of Terrebonne/Timbalier Bays with a segmented breakwater from the Seabreeze area to the Little Lake area. This feature would rebuild and maintain the historic shoreline integrity around Terrebonne and Timbalier Bays by constructing segmented barriers along the west side of Terrebonne Bay, across the historic shoreline alignment along the northern sides of both bays, and along the eastern side of Timbalier Bay.

Relocate the Atchafalaya Navigation Channel

This restoration feature consists of relocating the Atchafalaya Navigation Channel. The navigation channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the channel between the delta lobes, and by using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the growing delta.

Terrebonne Basin barrier shoreline restoration

This restoration feature provides for the restoration of the Timbalier and Isles Dernieres barrier island chains. This would simulate historical conditions by reducing the current number of breaches, enlarging (width and dune crest) of the Isles Dernieres (East Island, Trinity Island, and Whiskey Island) and East Timbalier Island.

Stabilize banks of Southwest Pass

This restoration feature would maintain the integrity of Southwest Pass of the Atchafalaya River by protecting its bay and gulf shorelines. This feature would involve the construction of a dike and armoring of the banks of the pass to maintain the existing pass dimensions.

Gulf shoreline stabilization at Point Au Fer Island

This feature provides for stabilizing of the gulf shoreline of Point Au Fer Island. The purpose is to prevent direct connections from forming between the gulf and interior water bodies as the barrier island is eroded. In addition to gulf shoreline protection, this feature would prevent the fresher bay side water circulation patterns from being influenced directly by the gulf, thus protecting the estuarine habitat, which has higher quality wetland habitats, from conversion to marine habitat.

Alternative operational schemes of Old River Control Structure (ORCS)

This feature would evaluate alternative ORCS operational schemes with a goal of increasing the sediment load transported by the Atchafalaya River for the purpose of benefiting coastal wetlands. Detailed studies of this feature would determine: impacts (beneficial and adverse) to the interior of the Atchafalaya Basin; the degree to which flow and sediment redistributions would be required; and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red, and Atchafalaya Rivers.

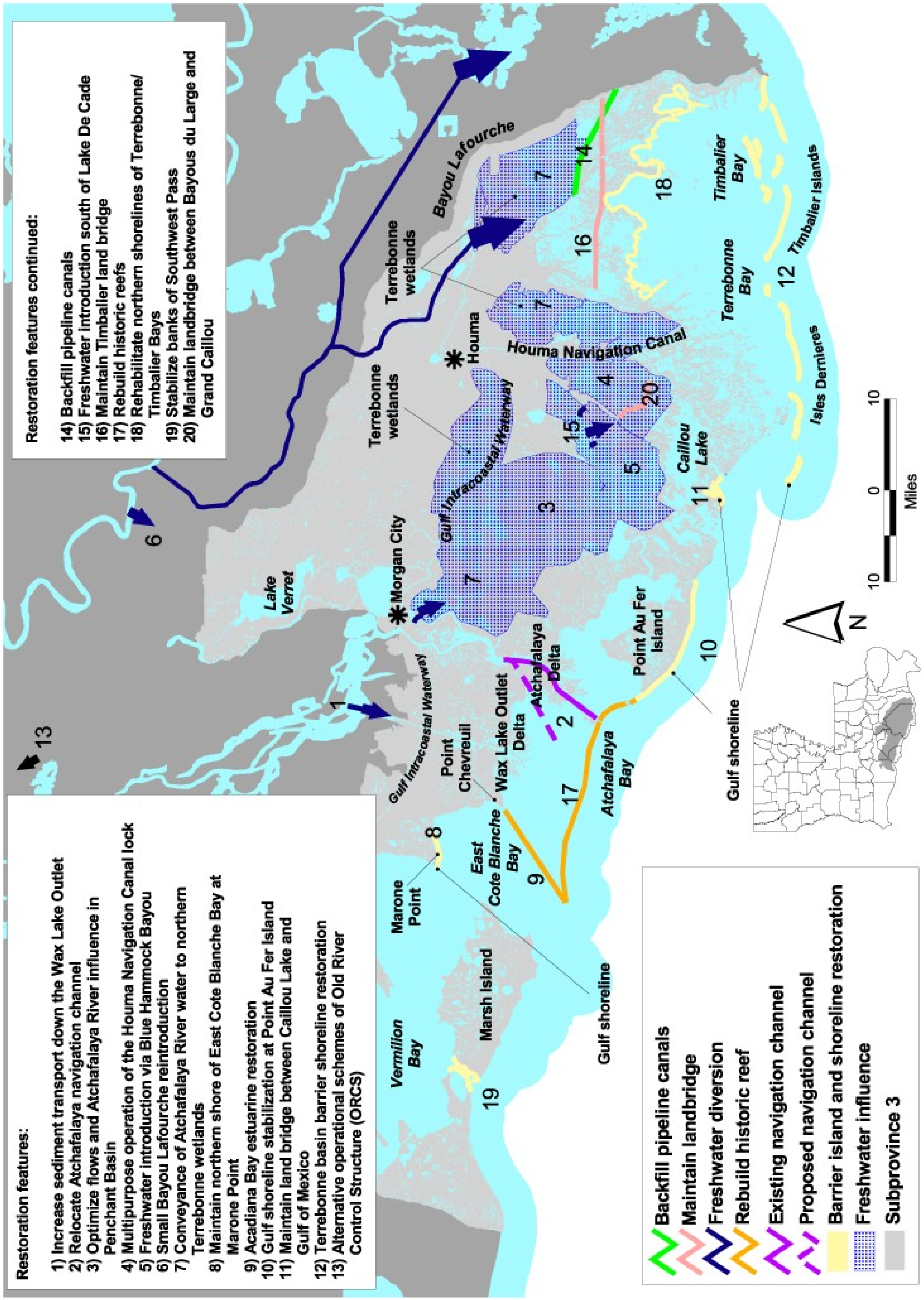


Figure E-48. Subprovince 3 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

7.1.4 Subprovince 4 feature descriptions

Black Bayou bypass culverts

This restoration feature involves the replacement of the Calcasieu Lock in the GIWW west of the Hwy 384 Bridge and uses the old lock for freshwater introduction to the upper Calcasieu estuary from the Mermentau Basin. This feature also incorporates freshwater introduction via the Black Bayou Culverts feature at the intersection of Black Bayou and Hwy 384.

Calcasieu Ship Channel Beneficial Use

This feature capitalizes on the existing navigation maintenance activity by expanding beneficial use of dredged material from the Calcasieu Ship Channel. It accomplishes this by extending the application of material dredged from the channel for routine maintenance beyond the normal standard. Average annual maintenance dredging volume is approximately 4,000,000 cubic yards. The expanded use of this material would result in wetland creation over 50 years of application.

Chenier Plain freshwater management and allocation reassessment

This restoration opportunity requires detailed investigations involving water allocation needs and trade-off analysis in the eastern Chenier Plain, including the Teche/Vermilion Basin, to provide for wetland restoration and support continued agriculture and navigation in the region. A series of navigation and salinity control structures are currently authorized and operated in the eastern portion of the Chenier Plain. These structures maintain a freshwater source for agricultural applications and prevention of salinity intrusion in the area. Tidal stages have predominantly exceeded stages within the managed area creating a ponding issue for the fresh and intermediate marshes in the area. In addition, the natural ridges that define this area continue to be impacted by erosion, further threatening the ability for continued management and sustainability of the interior marshes. The study would address water management and allocation issues including salinity control, drainage, and fisheries accessibility.

Dedicated dredging for marsh restoration

This restoration feature would apply dredged material from offshore sources beneficially to restore subsided wetlands on Sabine National Wildlife Refuge (NWR) and adjacent properties. Locations for marsh restoration would be north and northwest of Browns Lake on Sabine NWR. Average open water depth is 1.5 to 2 feet deep.

East Sabine Lake hydrologic restoration

This restoration feature involves restoration of East Sabine Lake between Sabine Lake and Sabine NWR Pool 3. This feature would include salinity control structures at Willow Bayou, Three Bayou, Greens Bayou, and Right Prong of Black Bayou. Sediment terracing would also be used in shallow open water areas along with shoreline protection along Sabine Lake and some smaller structures.

Freshwater introduction at Highway 82

This restoration feature provides for drainage of “excess” freshwater from the Mermentau Basin Lakes Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Little Pecan Bayou

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Pecan Island

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 near Pecan Island to the Chenier Subbasin. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Rollover Bayou

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 at Rollover Bayou to the Chenier Subbasin. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater Introduction at South Grand Chenier

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou watershed. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Stabilize Gulf shoreline near Rockefeller Refuge

This restoration feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Stabilization methods include rock foreshore dikes, offshore reefs, or segmented breakwaters, similar to Holly Beach breakwaters, placed closer to shore and with narrower gaps. The objective of this feature is the prevention of shoreline breaching into the landward brackish and intermediate marshes.

Modify existing Cameron-Creole watershed structures

The Cameron-Creole watershed feature, constructed in 1989, consists of 5 large concrete water control structures and a 16 mile-long levee along the shoreline of Calcasieu Lake. Three of the five structures (Grand Bayou, Bois Connine Bayou, and Lambert Bayou) are adjustable structures with slide gates and the remaining two (Mangrove Bayou and No Name Bayou) are fixed crest weir structures. The fixed crest weir sill heights may be set too high. This higher setting could be contributing to the impoundment problem within Cameron-Creole marshes adjacent to those structures. If the weir sills for these two structures could be modified to lower weir crests, reduced impoundment, greater water flow, and increased fisheries access would occur independent of salinity control at Calcasieu Pass.

New Lock at the GIWW

This feature consists of a new lock at the GIWW east of Alkali Ditch with dimensions of 75 to 110 feet wide by 15 feet deep. This restoration feature would limit the exchange of water between the Sabine River and the GIWW eastward to the Calcasieu River. The existing circulation pattern provides a mechanism for the intrusion of higher salinity waters transmitted by the deeper navigation channels in each of the rivers to reach the interior marshes. The objective of the feature is the reduction of circulation of higher salinity water through the Calcasieu-Sabine sub-basin, thereby reducing future wetlands loss.

Salinity control at Alkali Ditch

This restoration feature provides salinity control at the Alkali Ditch, northwest of Hackberry at the GIWW, with a gated structure or rock weir with barge bay. The existing dimensions of the feature are approximately 150 to 200 feet wide by 8 to10 feet deep; the structure or weir with approximate dimensions 70 feet wide by 8 feet deep. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Black Bayou

This restoration feature calls for a salinity control structure with boat bay at the mouth of Black Bayou (either a gated structure or a rock weir), located at the intersection of Black Bayou and the northeastern shoreline of Sabine Lake. The existing bayou dimensions are 150 to 200 feet wide by 10 feet deep. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Black Lake Bayou

This restoration feature calls for salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27, west of the Calcasieu Ship Channel. The existing dimensions are 40 feet wide by 5 feet deep. The structure’s approximate dimensions are 10 to 15 feet wide by 4 feet deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Highway 82 Causeway

This restoration feature provides for a rock weir at Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass and the Sabine-Neches Waterway. Existing dimensions of the facility equal approximately 3,400 feet wide by approximately 4 feet deep, except at the approximate 10 feet deep center channel. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Long Point Bayou

This restoration feature provides for salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27, west of the Calcasieu Ship Channel. The existing dimensions are 40 feet wide by 5 feet deep. The structure's approximate dimensions are 10 to 15 feet wide by 4 feet deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Oyster Bayou

This restoration feature provides for salinity control in Oyster Bayou with a gated structure or rock weir. The location in Oyster Bayou is about 1 mile west of the Calcasieu Ship Channel, which is 100 to 150 feet wide by 10 feet deep; with an approximately 15 to 20 foot wide by 4 foot deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

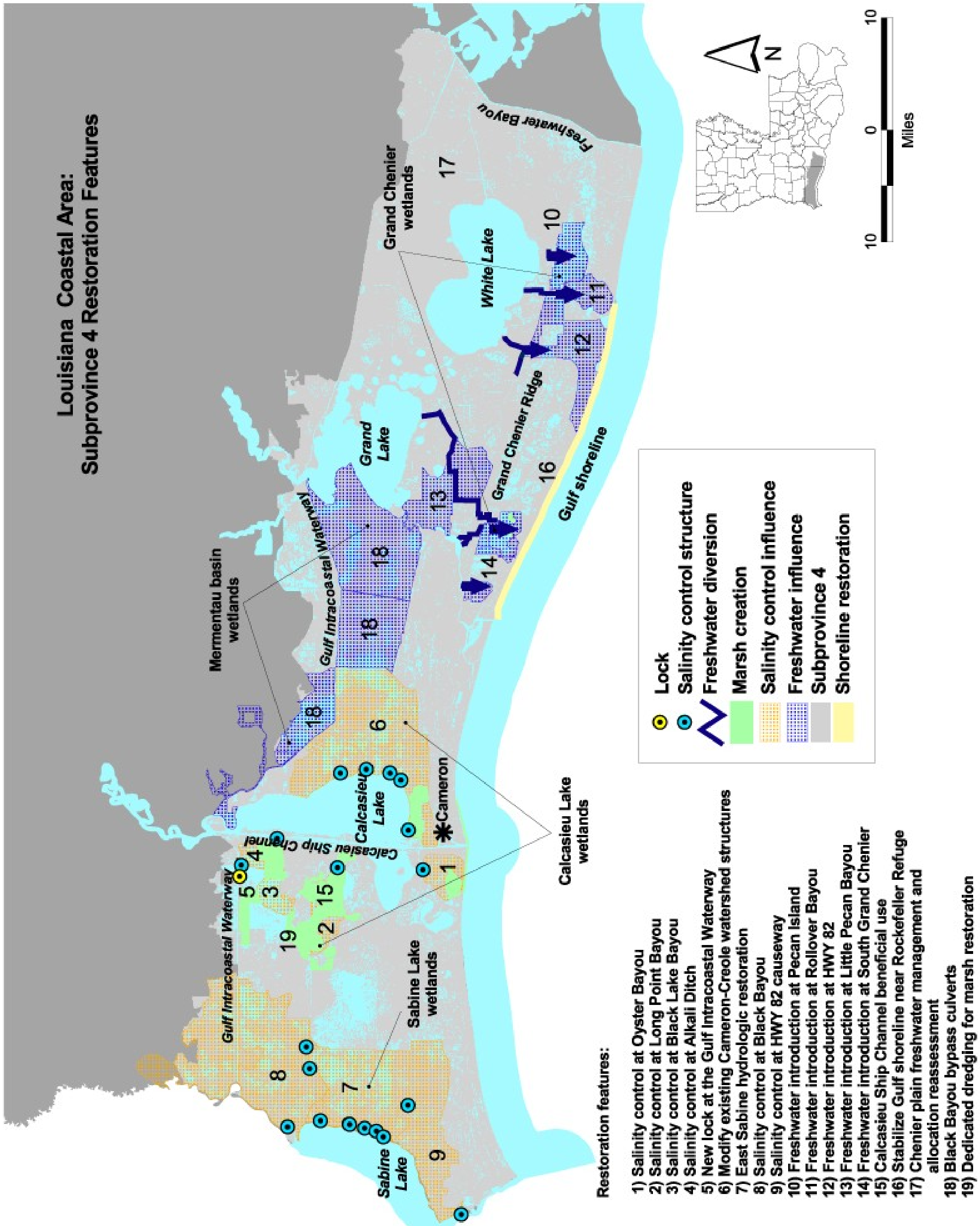


Figure E-49. Subprovince 4 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

7.2 Development of Sorting and Critical Needs Criteria

The PDT determined that use of initial sorting criteria and follow-on critical needs criteria-based evaluations was an appropriate method to determine which of the 79 features would best meet near-term requirements. Criteria were developed to identify which restoration features would be placed into the various component categories described previously. In addition, the criteria helped identify the ability of each restoration feature to address critical needs.

The initial step in identifying these criteria was the gathering of input by the PDT. The Vertical Team, Framework Development Team, and the PDT developed a methodology to: 1) sort the restoration features into the component categories of the alternative LCA Plans; and 2) identify the relative value of a restoration feature in addressing critical ecologic needs in the coastal landscape. The criteria were designated as either "sorting" or "critical needs" criteria. The PDT designated three sorting criteria, and four critical need criteria.

7.2.1 Sorting criteria

7.2.1.1 Sorting Criterion #1 - Engineering and design complete and construction started within 5 to 10 years

A restoration feature would meet this criterion if, over the next 5 to 10 years:

- Required feasibility-level decision documents were completed;
- Necessary NEPA documentation were completed;
- Pre-construction engineering & design (PED) were completed; and
- Construction authorization was obtained and construction was initiated.

If a restoration feature did not meet this criterion, it was not viewed as a potential near-term restoration opportunity, but rather a potential candidate for large-scale and long-range study.

7.2.1.2 Sorting Criterion #2 - Based upon sufficient scientific and engineering understanding of processes

A restoration feature would successfully meet this criterion if it contained:

- Opportunities for which there is currently a sound understanding based in science and technology; and
- Science and engineering principles that have been applied within Louisiana and successfully achieved a beneficial ecosystem response.

Features that did not meet this criterion were not considered as potential near-term restoration opportunities. Instead, the scientific and/or engineering uncertainties associated with these restoration features provided a basis for the feature to be a potential candidate for a demonstration project.

7.2.1.3 Sorting Criterion #3 - Implementation is independent; does not require another restoration feature to be implemented first

If a feature was not deemed to be independent, other features that potentially had overlapping or duplicative effects were identified, and the interdependent features were combined. This combination of features was then reassessed to determine if, as a composite, the group of features met the initial two sorting criteria and classified appropriately.

The sorting criteria were applied sequentially. In other words, if a feature failed to meet criterion #2, then it was not reviewed to assess whether it met criterion #3. The process of applying these sorting criteria is represented in the flow diagram in **figure E-50**.

7.2.2 Critical needs criteria

If a restoration feature met all of the sorting criteria, it was then assessed against the critical needs criteria. The application of the criteria was done in an annotated manner so that the reasoning for applicability of each feature versus the criteria could be readily assessed. This approach allowed the PDT to make relative comparisons of different features based on common criteria and fine tune the overall value of features in addressing the critical ecologic and human needs of the system. The following criteria were applied to potential near-term course of action features as defined.

7.2.2.1 Critical Needs Criterion #1 - Prevents future land loss where predicted to occur

One of the most fundamental drivers of ecosystem degradation in coastal Louisiana has been the conversion of land (mostly emergent vegetated wetland habitat) to open water. One of the most fundamental critical needs is to stem this loss. Thus, the projection of the future condition of the ecosystem must be based upon the determination of future patterns of land and water. Future patterns of land loss were based on the USGS open file report 03-334 “Historical and Predicted Coastal Louisiana Land Changes: 1978-2050” (appendix B HISTORIC AND PROJECTED COASTAL LOUISIANA LAND CHANGES: 1978-2050). This also applies to future predicted conversion of cypress swamp in areas with existing fragmenting marsh.

7.2.2.2 Critical Needs Criterion #2 - (Sustainability) Restores fundamentally impaired (or mimics) deltaic function through river reintroductions

This criterion refers to opportunities that would restore or mimic natural connections between the river and the basins (or estuaries), including distributary flows, crevasses, and over-bank flow. Mechanical marsh creation with river sediment was also viewed as mimicking the deltaic function of sediment introduction if supported by sustainable freshwater and nutrient reintroduction.

7.2.2.3 Critical Needs Criterion #3 - (Sustainability) Restores or preserves endangered critical geomorphic structure

This criterion identifies opportunities that would restore or maintain natural geomorphic structures such as barrier islands, distributary ridges, cheniers, land bridges, and beach and lake rims. These geomorphic structures are essential to maintaining the integrity of coastal ecosystems. Those structures that are endangered or "nearly lost" in the near-term are especially critical.

7.2.2.4 Critical Needs Criterion #4 - Protects vital socio-economic resources

This criterion identifies proposed opportunities that would potentially protect vital local, regional, and national social, economic, and cultural resources. These resources include cultures, community, infrastructure, business and industry, and flood protection.

7.2.3 Application of the criteria

Following the identification of these restoration criteria and the method for their application, the PDT made an initial assessment of the 79 restoration features. This assessment indicated that the methodology could be applied effectively to identify potential alternative plans.

During the week of April 19 to 23, 2004, a series of public scoping meetings were held across the LCA Study area. These meetings provided the public and stakeholder groups an opportunity to comment on the modification of the study and the specific criteria for identifying alternative LCA Plans. The participants were provided with an overview of the criteria and methodology, the written definition of each criterion's application, and a list of the 79 features. This information was also made available on the study's web site along with additional feature details. The meeting participants were encouraged to comment on and/or modify the criteria and methodology developed by the PDT, as well as to provide input on additional criteria that they considered appropriate. Finally, attendees were encouraged to take materials to other interested parties who were not able to attend or direct them to the study's web site to submit their comments.

The public input was compiled and used to make adjustments to the criteria or to the criteria's application to individual features. In addition, public input allowed the PDT to make final assessments of the appropriate components of the alternative LCA Plans.

7.2.4 Development and evaluation of alternative plans

As detailed previously, application of the three sorting criteria and four critical needs criteria was the basis for development of alternative plans composed of near-term critical features, candidate large-scale studies, and candidate science and technology demonstration projects. The sorting criteria application that determined what were the possible near-term critical features among the 79 initial features was considered fixed. The best opportunity to develop alternative plans resided in the application of the critical needs criteria to determine the near-term critical features. While each of the critical needs criteria were supporting and complimentary, it was possible to discern alternative combinations of near-term critical features by applying the criteria individually or in varying combinations.

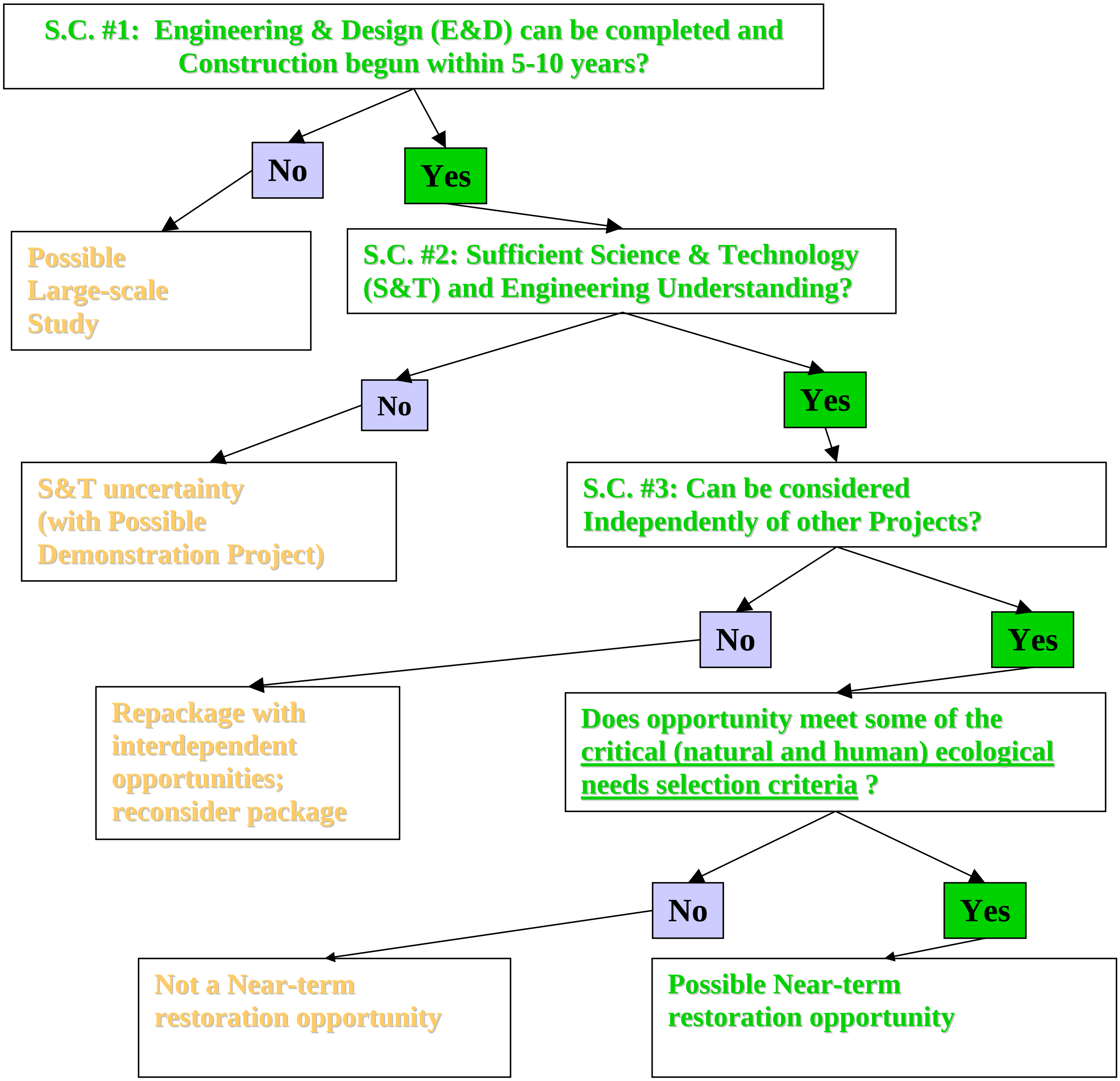


Figure E-50. LCA Sorting Process Flow Diagram.

7.3 Sorting Criteria Application Results

During Phase VI, each of the 79 restoration features was analyzed through the three Sorting Criteria (**figure E-50**) and four Critical Needs Criteria. These criteria were designed to determine whether or not a restoration feature should be incorporated as a near-term component in one or more of the LCA alternative plans. In addition, if it was determined that a feature was to be included in the near-term course of action, the criteria helped determine in which component category it would best fit. For example a restoration feature could represent a potential near-term critical restoration feature or a potential large-scale study for a promising restoration concept. Alternatively, an overarching scientific or technological uncertainty could be associated with a restoration feature that would first require the development and implementation of an appropriately scaled demonstration project prior to the implementation of the feature.

7.3.1 Results of Applying Sorting Criterion #1: Engineering and Design (E&D) can be Completed and Construction Started within 5 to 10 Years

Application of Sorting Criterion #1 winnowed down the number of potential restoration features from 79 to 61. Those restoration features deemed too complex to have feasibility-level decision documents complete and construction begun within the next 5 to 10 years of plan implementation did not successfully pass through this sorting criterion and were instead considered for inclusion in the LCA Plan alternatives as potential large-scale studies. **Table E-46** lists those restoration features that did not meet Sorting Criterion #1 and were, therefore eliminated from further consideration as near-term plan restoration features.

Table E-46. Restoration Features Eliminated using Sorting Criterion #1: Features Whose E&D Could not be Ccompleted and Construction Started Within the Next 5 to 10 Years

Subprovince 1

- Medium diversion at Bonnet Carre Spillway
- Post authorization for the diversion of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands
- Medium to large sediment diversion at American/California Bays
- Mississippi River Delta Management Study (Subprovinces 1 & 2)

Subprovince 2

- Medium diversion at Edgard with sediment enrichment
- Large diversion at Boothville with sediment enrichment
- Medium diversion at Fort Jackson - Alternative to Boothville diversion
- Large diversion at Fort Jackson with sediment enrichment - Alternative to Boothville diversion
- Medium diversion at Lac Des Allemands with sediment enrichment
- Large diversion at Myrtle Grove with sediment enrichment
- Third Delta (Subprovinces 2 & 3)

Subprovince 3
- Relocate the Atchafalaya Navigation Channel
- Increase sediment transport down Wax Lake Outlet
- Alternative operational scheme of the Old River Control Structure (ORCS)
- Acadiana Bay Estuarine Restoration
- Rebuild historic reefs - Rebuild historic barrier between Point Au Fer and Eugene Island and construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west

Subprovince 4
- Chenier Plain freshwater management and allocation reassessment*
    - Freshwater introduction at South Grand Chenier
    - Freshwater introduction at Pecan Island
    - Freshwater introduction at Rollover Bayou
    - Freshwater introduction at Highway 82
    - Freshwater introduction at Little Pecan Bayou
- New lock at the GIWW

** These features did not pass Sorting Criterion #3, were repackaged and are considered as a potential large-scale study within the Chenier Plain Freshwater Management and Allocation Study*

7.3.2 Results of Applying Sorting Criterion #2: Sufficient S&T and Engineering Understanding of Processes

Of the 61 features that met Sorting Criterion #1, 27 did not successfully meet Sorting Criterion #2 because they contained some form of scientific or technical uncertainty that would require resolution prior to their implementation. The various types of uncertainties are described in section 3.1 PLANNING CONSTRAINTS. These uncertainties may be resolved by the development and implementation of an appropriately scaled demonstration project (the specific features may suggest demonstration project locations). **Table E-47** lists features that did not meet Sorting Criterion #2 and were, therefore eliminated from further consideration as near-term course of action restoration features.

Table E-47. Restoration Features Eliminated Using Sorting Criterion #2: Features Having Significant Uncertainties About Science and Technology and Engineering Understanding of Processes.

Subprovince 1
- Marsh nourishment on New Orleans East land bridge
- Sediment delivery via pipeline at La Branche wetlands
- Sediment delivery via pipeline at American/California Bays
- Sediment delivery via pipeline at Central Wetlands
- Sediment delivery via pipeline at Ft. St. Philip
- Sediment delivery via pipeline at Golden Triangle
- Sediment delivery via pipeline at Quarantine Bay
- Opportunistic use of Bonnet Carre Spillway (CWPPRA project)

Subprovince 2
- Implement the LCA Barataria Basin Wetland Creation and Restoration Study
- Sediment delivery via pipeline at Bastian Bay/Buras
- Sediment delivery via pipeline at Empire
- Sediment delivery via pipeline at Main Pass (Head of Passes)

Subprovince 3
- *Maintain land bridge between Bayous du Large and Grand Caillou*
- Maintain Timbalier land bridge
- Backfill pipeline canals
- Freshwater introduction south of Lake De Cade

Subprovince 4
- Salinity control at Alkali Ditch
- Salinity control at Highway 82 Causeway
- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Black Bayou Bypass culverts
- Dedicated dredging for marsh restoration
- Stabilize Gulf shoreline near Rockefeller Refuge
- Modify existing Cameron-Creole watershed structures
- East Sabine Lake hydrologic restoration
- Salinity control at Black Bayou

7.3.3 Results of Applying Sorting Criterion #3: Implementation is Independant; Does not Require Other Restoration Feature to be Implemented First

The remaining 34 features were next subjected to Sorting Criterion #3 to determine their independence from other restoration features. When running these remaining features through Sorting Criterion #3, 13 features were deemed to be independent (received a “Yes” for this criterion). These 13 features then proceeded to the Critical Needs Criteria evaluation. The 21 features that were determined to be interdependent (received a “No” for this criterion) were combined with other dependent features(s), as appropriate, to create “restoration opportunities”. The combined restoration opportunities were evaluated again using Sorting Criteria 1, 2, and 3. One of the restoration opportunities, Freshwater Reintroductions into Subprovince 4, (consisting of five features) failed to pass Sorting Criterion #1 and was reserved as a potential concept for large-scale studies and eliminated from consideration as a near-term restoration opportunity. The remaining 6 restoration opportunities (consisting of 16 features) passed both criteria 1 and 2 and were included for further consideration as near-term restoration opportunities. **Table E-48** identifies the 13 restoration features and 6 combined restoration opportunities (made up of 16 restoration features) that were further evaluated using the Critical Needs Criteria. **Figure E-51** provides a graphic representation of the Sorting Criteria Evaluation Process.

Table E-48 –Restoration Features and Restoration Opportunities that Passed Sorting Criteria 1 to 3:

Subprovince 1

- MRGO Environmental Restoration Features
- Maurepas Swamp Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Small diversion at Hope Canal (CWPPRA Maurepas Diversion)
  - Small diversion at Convent / Blind River
  - Increase Amite River Diversion Canal influence by gapping banks
- Upper Breton Sound Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Modification of Caernarvon diversion
  - Medium diversion at White's Ditch
- Lower Breton Sound Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Rehabilitate Bayou Lamoque structure as a medium diversion
  - Medium diversion at American / California Bays
- Rehabilitate Violet Siphon for enhanced influence to Central Wetlands
- Medium diversion at Fort St. Philip

Subprovince 2

- Barataria Basin barrier shoreline restoration
- Mid-Barataria Basin Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Modification of Davis Pond diversion for increased sediment input
  - Medium diversion with dedicated dredging at Myrtle Grove
- Lac Des Allemands Area Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Small diversion at Lac Des Allemands
  - Small diversion at Donaldsonville
  - Small diversion at Pikes Peak
  - Small diversion at Edgard

Subprovince 3

- Small Bayou Lafourche reintroduction
- Terrebonne Marsh Restoration Opportunity
  This restoration opportunity includes the following features:
  - Optimize flows and Atchafalaya River influence in Penchant Basin
  - Multi-purpose operation of Houma Navigation Canal (HNC) Lock
  - Convey Atchafalaya River water to Terrebonne Marshes via a small diversion in the Avoca Island Levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction / enlargement
- Terrebonne Basin barrier shoreline restoration

- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Gulf shoreline stabilization at Point Au Fer Island
- Maintain northern shore of East Cote Blanche Bay at Point Marone
- Rehabilitate Northern Shorelines of Terrebonne / Timbalier Bays
- Stabilize banks of Southwest Pass
- Freshwater introduction via Blue Hammock Bayou

Subprovince 4

- Calcasieu Ship Channel Beneficial Use

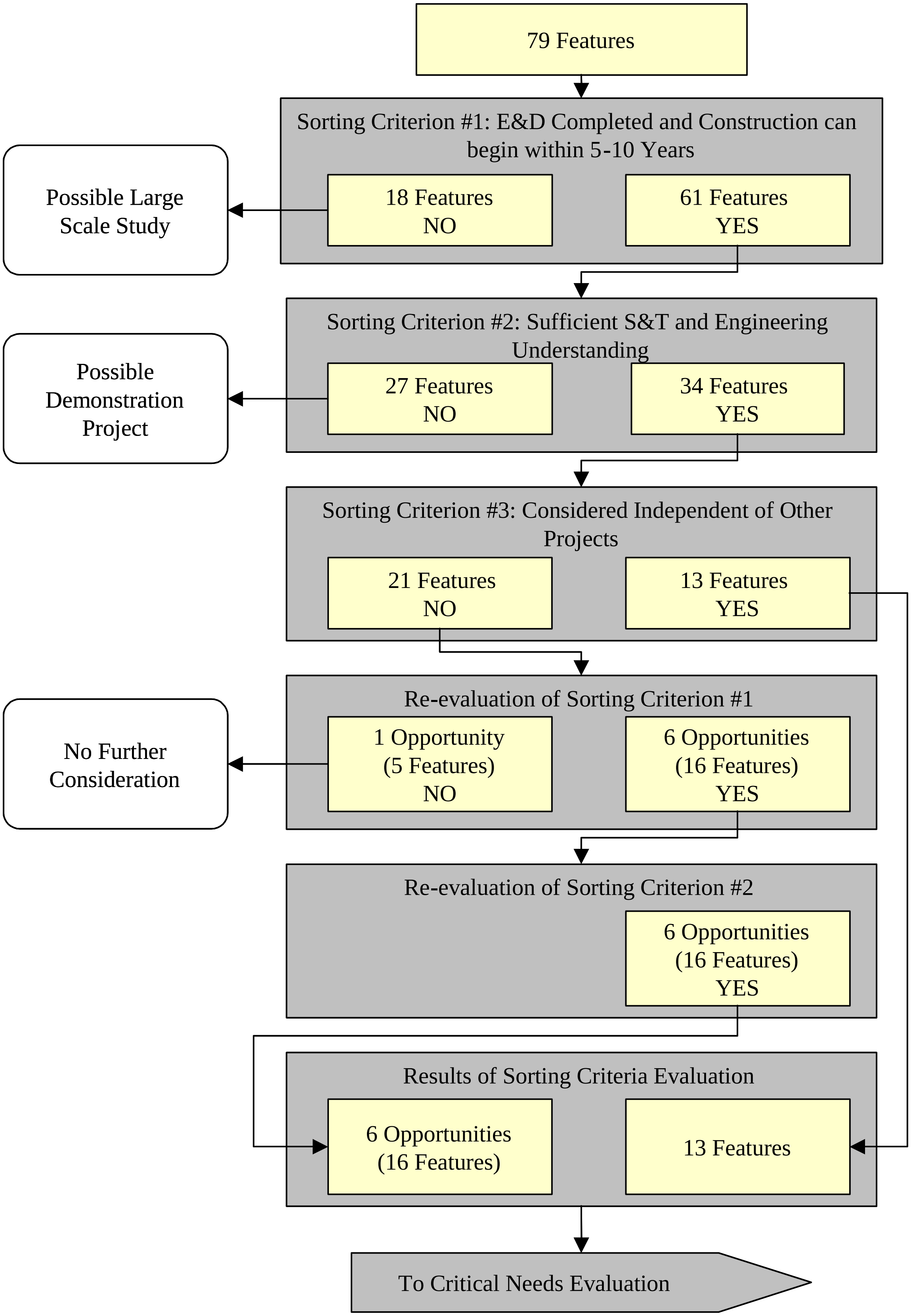


Figure E-51. Application of Sorting Criteria to Restoration Features and Opportunities.

7.4 Critical Needs Criteria Application Results

Following the application of Sorting Criteria, the 13 restoration features and 6 restoration opportunities (made up of 16 restoration features) were further evaluated using the Critical Needs Criteria. Annotated comments were developed for each feature and opportunity to identify the particular Critical Need Criteria that a component met (or did not meet), as well as the relative ability of the feature or opportunity to address them. After evaluating the 13 features and 6 restoration opportunities using the Critical Needs Criteria, 7 features and 5 restoration opportunities (made up of 14 restoration features) were determined to meet the Critical Needs Criteria. These features and opportunities were used to form the basis of the alternative near-term courses of action. Alternately, 6 features and 1 restoration opportunity (made up of 2 restoration features) did not meet the Critical Needs Criteria, and were not considered for inclusion in the near-term course of action. Below are the annotated comments of the results of the assessment of individual features and restoration opportunities following application of the four Critical Needs Criteria.

7.4.1 Features Having Significant "Critical Needs Criteria" Value

7.4.1.1 Subprovince 1

MRGO Environmental Restoration Feature

This feature addresses Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent predicted future land loss and restore previously degraded wetlands; stabilize and restore the endangered, critical lake rim geomorphic structure; and protect vital socio-economic resources, such as developments located adjacent to the confluence of the MRGO with the GIWW.

Maurepas Swamp Reintroductions Opportunity

The Maurepas Swamp Reintroduction Opportunity includes the following features:

- Small diversion at Hope Canal (CWPPRA Maurepas Diversion)
- Small diversion at Convent / Blind River
- Increase Amite River Diversion Canal influence by gapping banks

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future cypress swamp degradation and transition currently predicted to occur; restore the deltaic process impaired by levee and dredged material bank construction; and protect vital socio-economic and public resources, such as the growing eco-tourism industry resident in the Maurepas Swamp and the Maurepas Wildlife Management Area.

Upper Breton Sound Reintroductions Opportunity

The Upper Breton Sound Reintroduction Opportunity includes the following features:

- Modification of Caernarvon diversion
- Medium diversion at White's Ditch

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 2 and 4. Specifically, this opportunity has the potential to restore the deltaic process impaired by levee construction at locations where historic crevassing has occurred and protect vital socio-economic resources located in areas along the east bank of the Mississippi River in Plaquemines Parish within hurricane flood protection levees. This opportunity also includes features that capitalize on existing structures, such as the Caernarvon diversion.

7.4.1.2 Subprovince 2

Barataria Basin Barrier Shoreline Restoration Feature

This restoration feature has multiple components, some of which have potential to address Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: preventing major future land loss where currently predicted to occur; restoring endangered, critical geomorphic structure at the gulfward boundary of the Barataria system; and protecting vital socio-economic resources, such as oil and gas infrastructure located on the leeward side of these islands. However, this feature entails some aspects of technical uncertainty in the availability and quality of source material, delivery material by pipeline, and durability.

Mid-Barataria Basin Reintroductions Opportunity

The Mid-Barataria Basin Reintroduction Opportunity includes the following features:

- Modification of Davis Pond diversion for increased sediment input
- Medium diversion with dedicated dredging at Myrtle Grove

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent significant future land loss where currently predicted to occur; restore the deltaic process impaired by the construction of levees at locations where historic crevassing has occurred, as well as improve water quality; and protect vital socio-economic resources located in the central and upper portions of the Barataria Basin. This opportunity would also capitalize on the existing Davis Pond diversion structure.

Lac Des Allemands Area Reintroductions Opportunity

The Lac Des Allemands Area Reintroductions Opportunity includes the following features:

- Small diversion at Lac Des Allemands
- Small diversion at Donaldsonville
- Small diversion at Pikes Peak
- Small diversion at Edgard

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent significant future land loss where currently predicted to occur; restore the deltaic process impaired by levee construction in areas where historic crevassing has occurred; and protect vital socio-economic resources such as the eco-tourism industry and residents in the upper Barataria Basin.

7.4.1.3 Subprovince 3

Small Bayou Lafourche Reintroduction Feature

This feature would reintroduce flow from the Mississippi River into Bayou Lafourche and addresses Critical Needs Criteria 1, 2, and 4. Specifically, this feature has the potential to: prevent future land loss where predicted to occur; restore a fundamentally impaired deltaic process by reintroducing water to a historic distributary of the Mississippi; and protect vital community and socioeconomic resources by supplementing channel flow and stabilizing water quality.

Terrebonne Basin Barrier Shoreline Restoration Feature

This restoration feature has multiple components, some of which have potential to address Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent future barrier island losses where predicted to occur; restore endangered, critical geomorphic structure; and protect vital socio-economic resources such as oil and gas infrastructure and fisheries. However, this feature entails some aspects of technical uncertainty in the availability and quality of source material, delivery of material by pipeline, and durability.

Maintain Land Bridge Between Caillou Lake and Gulf of Mexico Feature

This restoration feature addresses Critical Needs Criteria 1 and 3. This feature would stem shoreline retreat and prevent further breaches that have allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Prevention of increased marine influence would reduce interior wetland loss as well as preserve the potential for long-range restoration. Closure of newly opened channels would restore historic cross-sections of exchange points, would reduce marine influences in interior areas, and allow increased freshwater influence from Four League Bay to benefit area marshes.

Gulf Shoreline Stabilization at Point Au Fer Island Feature

This feature addresses Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent future shoreline retreat where predicted to occur; restore endangered, critical geomorphic structure by stabilizing the island shoreline; and protect vital community and socio-economic resources.

Terrebonne Marsh Restoration Opportunity

The Terrebonne Marsh Restoration Opportunity includes the following features:

- Optimize flows and Atchafalaya River influence in Penchant Basin
- Multi-purpose operation of Houma Navigation Canal (HNC) Lock
- Convey Atchafalaya River water to Terrebonne Marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging

constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction/enlargement

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future land loss where predicted to occur; restore fundamentally impaired deltaic processes through the re-introduction of Atchafalaya River water; and protect vital community and socio-economic resources in the area, such as waterborne commerce and oil and gas infrastructure.

7.4.1.4 Subprovince 4

<u>Calcasieu Ship Channel Beneficial Use Feature</u>

This feature addresses Critical Needs Criteria 1 and 4. Specifically, this feature has the potential to prevent future land loss where predicted to occur and protect vital community and socio-economic resources of agricultural land use and oil and gas infrastructure. It also capitalizes on the existing navigation maintenance activity.

7.4.2 <u>Features and Opportunities Having Limited or No "Critical Needs Criteria" Value</u>

7.4.2.1 Subprovince 1

<u>Lower Breton Sound Reintroductions Opportunity</u>

The Lower Breton Sound Reintroductions Opportunity includes the following features:

- Rehabilitate Bayou Lamoque structure as a medium diversion
- Medium diversion at American/California Bays

This near-term restoration opportunity evaluates two features that have the potential to address Critical Needs Criteria 2 and 4. This opportunity also includes features that capitalize on existing structures, such as the Bayou Lamoque diversion. While this opportunity has some limited potential to restore the deltaic process in locations where historic crevassing has occurred, the proposed scale does not afford a significant influence on the critical need in the area. As a result, this opportunity was not included in any alternative plans.

<u>Rehabilitate Violet Siphon for Enhanced Influence to Central Wetlands Feature</u>

This feature has some effectiveness meeting Critical Needs Criteria 1 and 2. However, the existing structure has currently been rehabilitated and is operating to capacity on a regulated schedule. Therefore, this feature was not included in any alternative plans.

<u>Medium Diversion at Fort St. Philip Feature</u>

This feature has limited impact meeting Critical Needs Criterion #2. Specifically, this feature appears to have some limited potential to restore deltaic process in the area. However, the major ecologic need in the area is the introduction of large volumes of sediment. The assessment of this feature was that it fell low in the priority of possible critical near-term actions and was therefore not included in any alternative plans.

7.4.2.2 Subprovince 3

Maintain Northern Shore of East Cote Blanche Bay at Point Marone Feature

This feature addresses Critical Needs Criteria 1 and 3 to a minor extent. Specifically, this feature has the potential to prevent some limited future shoreline retreat where predicted to occur and restore some geomorphic structure by stabilizing a small portion of this bay shoreline. The assessment of this feature was that it fell low in the priority of possible critical near-term actions and was therefore not included in any alternative plans.

Rehabilitate Northern Shorelines of Terrebonne/Timbalier Bays Feature

This feature addresses Critical Needs Criteria 1 and 4. Specifically, this feature has the potential to prevent future shoreline retreat where predicted to occur and protect vital community and socio-economic resources. This feature potentially duplicates the effects of the Terrebonne Basin Barrier-shoreline Restoration feature. The assessment of this feature is that in the near-term the immediate stabilization of the existing barrier-shoreline features is a more effective option. While this feature could be investigated in conjunction with the barrier-shoreline feature, it was not included in any alternative plans.

Stabilize Banks of Southwest Pass Feature

While qualifying, with some effect relative to critical needs criteria, this feature does not appear to produce significant enough changes in the ecosystem to include it any alternative plans. The feature may be further investigated in conjunction with the large-scale Acadiana Bays Estuarine Restoration Study.

Freshwater Introduction via Blue Hammock Bayou Feature

While qualifying, with some effect relative to critical needs criteria, as near-term this feature it does not appear to produce significant enough changes in the ecosystem to include it any alternative plans.

7.5 Alternative Plan Evaluation Results

Table E-49 presents the 15 Alternative Plans (plus the No Action Alternative), provides the corresponding plan name (represented by the letters A – O), and identifies which Critical Needs Criterion/Criteria each specific alternative strived to meet. For example, Alternative Plans A, B, D, and H all focus on meeting one of the Critical Needs Criteria (1 through 4 respectively). The remaining 11 Alternative Plans were formulated to include all remaining possible mathematical combinations of the 4 Critical Needs Criteria.

Table E-49. Possible Alternative Plans and Associated Responsiveness to the Critical Needs Criteria.

Alternative Plan	Criterion 1 (Prevent Future Land Loss)	Criterion 2 (Riverine Reintroductions)	Criterion 3 (Restore Geomorphic Structure)	Criterion 4 (Protects Vital community & socio-economic resources)
A	X			
B		X		
C	X	X		
D			X	
E	X		X	
F	X	X	X	
G		X	X	
H				X
I	X			X
J		X		X
K	X	X		X
L	X		X	X
M			X	X
N	X	X	X	X
O		X	X	X
P (No Action)				

Using the annotated comments that resulted from the Critical Needs Criteria evaluation process, specifically the consensus opinion on which Critical Needs Criteria a restoration feature or opportunity best addresses, the PDT populated each of the 15 alternative plans with the restoration features and opportunities that successfully passed through both Screening and Critical Needs Criteria. For example, Alternative A includes all viable restoration features and opportunities that address Critical Needs Criteria 1 (preventing future land loss). Continuing the example, Alternative C is comprised of all viable restoration features and opportunities that address both Critical Needs Criteria 1 and 2 (prevent future land loss and utilizing riverine reintroductions). A summary restoration features restoration opportunities included in each of the 15 alternative plans is detailed in **table E-50**.

Table E-50 Alternative Plan Make-up

		Alternative Plans														
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
Restoration Feature or Opportunity	MRGO Environmental Restoration Features	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Maurepas Swamp Reintroduction Opportunities	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Barataria Basin Barrier Shoreline Restoration	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Small Bayou Lafourche Reintroduction	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Mid-Barataria Basin Reintroduction Opportunity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Upper Breton Sound Reintroduction Opportunity		X	X			X	X	X	X	X	X	X	X	X	X
	Calcasieu Ship Channel Beneficial Use	X		X	X	X	X	X		X		X	X	X	X	X
	Terrebonne Marsh Restoration Opportunity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Terrebone Basin Barrier Shoreline Restoration	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Maintain Land Bridge Between Caillou Lake and Gulf of Mexico	X		X	X	X	X	X		X		X	X	X	X	X
	Gulf Shoreline Stabilization at Point Au Fer Island	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Las Des Allemands Area Reintroductions Opportunity	X	X	X		X	X	X		X	X	X	X		X	X

Evaluation of the 15 alternatives was based on the identification of significantly different alternative plans to meet the study objectives and Critical Needs Criteria. As **table E-50** clearly shows, all of the restoration features and measures available to make up the suite of alternative plans were found in more than one Alternative Plan. This is due to the fact that all available restoration features and measures met multiple Critical Needs Criteria. For example, the MRGO Environmental Restoration Feature met Critical Needs Criteria 1, 3, and 4. Because of this, the process of identifying and delineating significantly different alternative plans was one in which the 15 alternative plans underwent intense scrutiny. A discussion of the composition of, and similarities and differences between, alternative plans follows.

7.5.1 Alternative Plans Designed to Meet Only 1 Critical Needs Criterion

Alternative A (the independent application of Critical Needs Criterion #1 (*prevention of predicted land* loss), resulted in a plan combination that excluded diversions in the Breton Sound Basin, but was inclusive of all other potential near-term features and opportunities. As such, Alternative A was grouped into the numerous alternative plans that sought to meet multiple Critical Needs Criteria.

Alternative B (the independent application of Critical Needs Criterion #2 (*sustainability through restored deltaic function*), also produced broad inclusion of potential features and opportunities, but uniformly excluded all barrier shoreline and marsh creation through dredged material use features. Alternative B also excluded any near-term opportunities in the Chenier Plain. However, this alternative was significantly different from the other 15 alternatives, and was carried forward for further evaluation.

Alternative D (the independent application of Critical Needs Criterion #3 (*sustainability through restoration of geomorphic structure*), produced a combination of features and opportunities focused on barrier shoreline restoration and direct land building focused on maintaining a protective structure. However, this alternative was significantly different from the other 15 alternatives, and was carried forward for further evaluation.

Alternative H (the independent application of Critical Needs Criterion #4 (*protection of vital socio-economic resources*), resulted in a diverse combination of features and opportunities that excluded restoration features and opportunities that did not directly benefit infrastructure or property. However, inclusion of Critical Needs Criterion #4 with any other criteria also provided a minor supplemental effect to most other possible alternative combinations. The absence of Critical Needs Criterion #4, in combination with any other criteria, results in only 2 to 3 feature or opportunity exclusions in any of those plans. In addition, Critical Needs Criterion #4, while defining a critical outcome of coastal restoration, could be more appropriately viewed as a synergistic factor in comparison to the critical needs for direct physical restoration of the landscape. As a result, it was determined that the independent application of criterion #4 did not produce a viable alternative plan. Therefore, Alternative H was not considered as a viable alternative plan.

7.5.2 Alternative Plans Designed to Meet Multiple Critical Need Criteria

Alternative plans seeking to meet multiple Critical Needs Criteria, particularly those that included Critical Needs Criterion #2, quickly reached full inclusion of all or nearly all the potential restoration features and opportunities. Three of the Alternative Plans (Alternatives E, J, and M), while intending to focus on meeting different Critical Needs Criteria, were comprised of almost the same restoration features and opportunities (+/- 4 features/opportunities). Likewise, eight of the Alternative Plans (Alternatives C, F, G, I, K, L, N, and O) had the exact same make-up i.e., they included all potential restoration features and opportunities. These 11 alternative plans were therefore grouped because, due to their similarity, they did not provide a true alternative choice (they were not significantly different). For the purpose of continued alternative plan evaluation, these 11 alternatives, and Alternative A described previously, were grouped and represented by Alternative Plan N because its inclusion of all potential restoration features and opportunities was an outcome of its design to meet all four Critical Needs Criteria.

7.5.3 Comparison of Alternative Plans

Summarizing the analysis results detailed above, three significantly different alternatives (Alternative Plans B, D, and N) arose. A comparison of the restoration features and opportunities, and construction costs estimates for these three alternative plans is provided in **table E-51**.

Table E-51. Comparison of Alternative Plan Feature Combinations and Construction Costs.

Potential Near-term Features	Alternative Near-term Plans		
	B	D	N
Mississippi River Gulf Outlet Environmental Environmental Restoration Features		$80,000,000	$80,000,000
Maurepas Swamp Reintroductions --			
Small Diversion at Convent / Blind River	$28,564,000		$28,564,000
Small Diversion at Hope Canal	$30,025,000		$30,025,000
Amite River Diversion (spoil bank gapping)	$2,855,000		$2,855,000
Barataria Basin Barrier Shoreline Restoration -- Caminada Headland, Shell Island		$181,000,000	$181,000,000
Small Bayou Lafourche Reintroduction	$90,000,000		$90,000,000
Medium Diversion with Dedicated Dredging at Myrtle Grove	$146,700,000		$146,700,000
Calcasieu Ship Channel Beneficial Use of Dredged Material		$100,000,000	$100,000,000
Modifcation of Caernarvon Diversion for Marsh Creation	$1,800,000		$1,800,000
Modifcation Davis Pond Diversion for Marsh Creation	$1,800,000		$1,800,000
Terrebonne Marsh Restoration Opportunities --			
Optimize Flows & Atchafalaya River Influence in Penchant Baisn	$9,720,000		$9,720,000
Multi-purpose Operation of the Houma Navigation Canal (HNC) Lock	$0		$0
Convey Atchafalaya River Water to Northern Terrebonne Marshes	$132,200,000		$132,200,000
Terrebonne barrier shoreline restoration -- Isle Derniere, E. Timbalier		$84,850,000	$84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico.		$41,000,000	$41,000,000
Medium Freshwater Diversion at White's Ditch	$35,200,000		$35,200,000
Stabilize Gulf Shoreline at Point Au Fer Island		$32,000,000	$32,000,000
Lac des Allemands area Reintroductions --			
Small Diversion at Lac des Allemands	$17,330,000		$17,330,000
Small Diversion at Donaldsonville	$16,670,000		$16,670,000
Small Diversion at Pikes Peak	$12,940,000		$12,940,000
Small Diversion at Edgard	$13,100,000		$13,100,000
Total Near-term Plan Construction Cost	**$538,904,000**	**$518,850,000**	**$1,057,754,000**

Alternative Plan B focused on restoration of deltaic processes (Critical Needs Criterion #2), and included 15 restoration near-term features and opportunities, all with combinations of river diversion features. Alternative Plan B exhibits some shortcomings because it does not address critical geomorphic structures. Alternative Plan D focused on restoration of geomorphic structure (Critical Needs Criterion #3), and included 11 restoration features and opportunities including shoreline protection, barrier island restoration, and marsh creation. Alternative Plan D exhibits some shortcomings because it does not address the river reintroductions. The body of knowledge concerning application of coastal restoration strategies in Louisiana suggests that while Alternative Plans B and D would have significant environmental benefits, they each exhibit some weaknesses in addressing the complete range of study planning objectives and Critical Needs Criteria.

Conversely, Alternative Plan N encompasses all four Critical Needs Criteria and exhibits potential for long-term sustainability because it contains the geomorphic structures which serve to protect and buffer the diversion feature influence areas from erosive coastal wave action and storm surge. Additionally, river diversion features are more sustainable because they are continuously connected to the river resource and nourished by its sediment and nutrients. **Figure E-52** provides a graphical representation of this discussion.

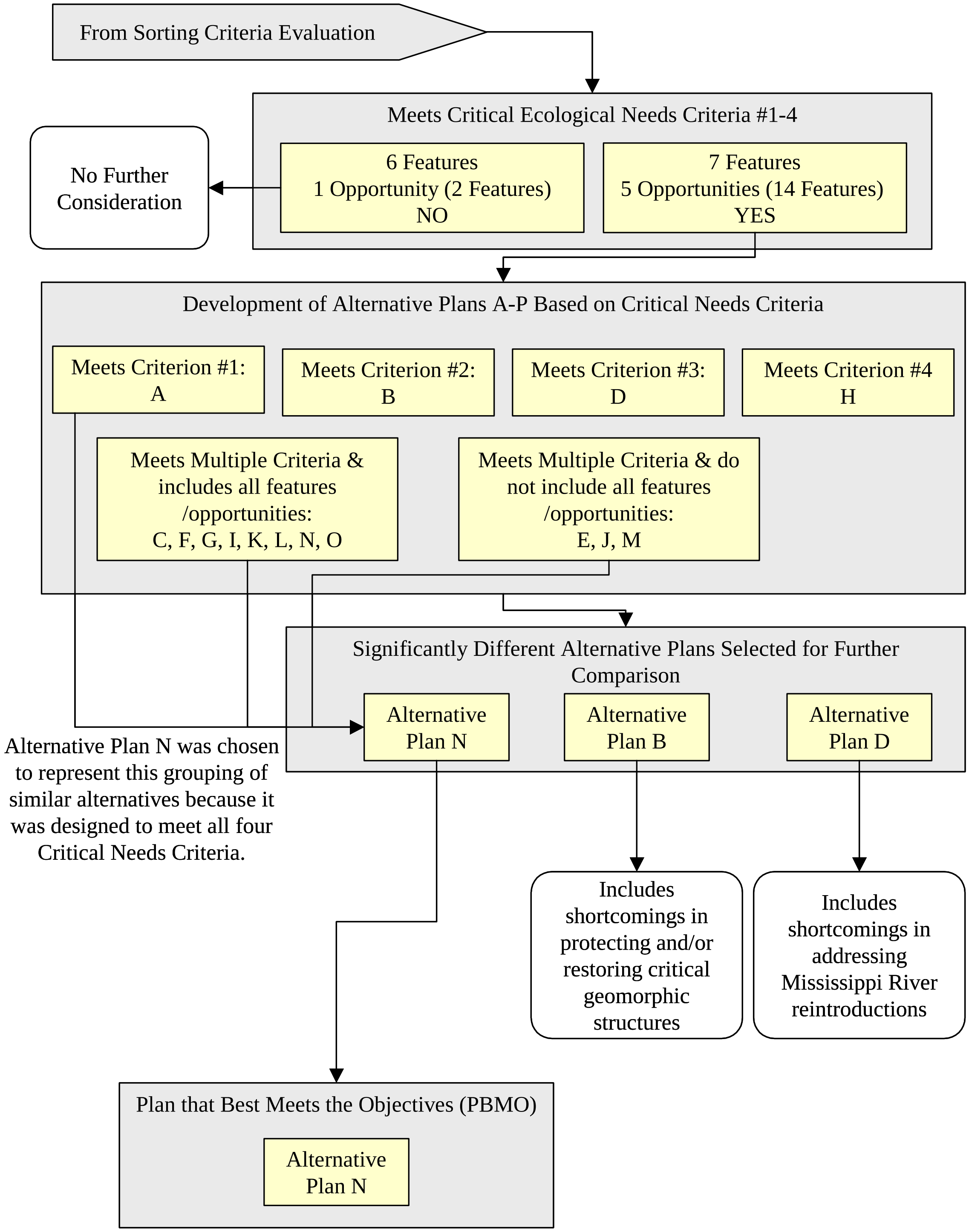


Figure E-52: Alternative Plan Development and Selection Based on Critical Needs Criteria.

7.6 Plan Formulation Results

7.6.1 Description of the Plan that Best Meets the Objectives

As discussed in section 3.2 PLAN FORMULATION RATIONALE and section 3.3 PLAN FORMULATION of the main report, the purpose of the LCA Study was to meet study objectives and thus identify a plan that is effective in addressing the most critical needs within the LCA. The most critical needs are located in those areas of the coast that, without attention, would experience a permanent or severely impaired loss of system stability and function. As such, the development and evaluation of alternative plans focused on identifying combinations of restoration features that best addressed these critical need areas.

The alternative plan that best meets the planning objectives (PBMO) is Alternative Plan N. Of the three alternative plans selected for further comparison, Alternative Plan N best meets the planning objectives and the Critical Needs Criteria.

In addressing the most critical ecologic needs of the Louisiana coast, this plan is also effective in meeting the defined study objectives. As presented previously in this report, the study objectives are as follows:

Hydrogeomorphic Objectives

1. Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (tidal action or exchange).
2. Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
3. Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

Ecosystem Objectives

1. Sustain productive and diverse fish and wildlife habitats.
2. Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

7.6.2 Effectiveness of the Plan in Meeting the Study Objectives

The PBMO addresses the most immediate and critical needs of the ecosystem in attaining the study objectives. The rehabilitation of the coastal ecosystem by promoting the distribution of riverine freshwater, nutrients, and sediments using natural processes and ensuring the structural integrity of the estuarine basins is key to this sustainable solution. A sustainable ecosystem would support Nationally significant living resources, provide a sustainable and diverse array of fish and wildlife habitats, reduce nitrogen delivery to offshore gulf waters, and provide infrastructure protection and a sustainable resource base necessary to support NER goals.

The PBMO accomplishes the stated Hydrogeomorphic Objective 1. In the Deltaic Plain, the PBMO identifies reintroductions of freshwater from the Mississippi River in multiple locations from small to moderate scales.

The PBMO also addresses Hydrogeomorphic Objective 2 as the recommended actions for the Deltaic Plain are founded primarily on the introduction of Mississippi River water and sediments. The PBMO identifies one restoration feature and three restoration opportunities (composed of seven features) for the introduction of Mississippi River water and recommendations for the investigation of rehabilitation or modification of two existing diversion structures in the Deltaic Plain. In addition, the PBMO identifies two restoration features capitalizing on the direct introduction of Mississippi River sediments. The PBMO directs attention to many areas where the prevention of wetland loss is critical to maintaining the ability to provide sustainable coastal restoration in the future. In the Chenier Plain, the PBMO focuses on providing continued stability to preserve the viability of future restoration actions.

Major components of the PBMO in the Deltaic Plain are directed at meeting Hydrogeomorphic Objective 3. The conservation and restoration of barrier islands and shorelines are large components of protecting the coastline from storm damage. Restoration features of the PBMO include a critical headland area and a critical land bridge in the deltaic plain. Proposed features and opportunities, located across the entire coast, assure that landscape features are restored and maintained to provide additional potential protection from storm damage.

Ecosystem Objective 1 is addressed by the PBMO, which contributes to the increased introduction of Mississippi River water and sediment, the improved management of Atchafalaya River water in the Deltaic Plain, and the expansion of beneficial use of dredged material in the Chenier Plain. The features recommended in the Deltaic Plain provide significant improvements in connectivity and material exchange.

While the overall quantity of wetland area is projected to increase with the execution of the proposed restoration effort, the cumulative quantities of suitable habitat are projected to decline for some species in localized areas of the coast. However, it was estimated that the overall useable amounts of the various habitat types would remain relatively plentiful throughout the 50-year period analyzed. Based on earlier ecological model analysis, certain saline species are anticipated to experience the most significant change in habitat levels. For most species across the coast, suitable habitat levels are expected to remain at or slightly below current levels. It is expected that many freshwater-associated species should see increases in levels of suitable habitat. These trade-offs are consistent with the reintroduction of deltaic land building processes. Even with the anticipated changes in cumulative habitat suitability, overall diversity is expected to remain relatively high and close to current conditions in keeping with the ecosystem objective.

The effectiveness of the PBMO in achieving Ecosystem Objective 2 has also been taken into account. An Action Plan goal was developed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and presented to Congress in January 2001. This goal calls for a 30 percent reduction in the mean annual load of total nitrogen delivered from the Mississippi

River basin to the Gulf of Mexico. Based on an average annual loading of 1.6 million metric tons (CENR, 2000), a 30 percent reduction would be 480,000 metric tons annually. In addressing the critical near-term needs of the coastal ecosystem, the PBMO would have a limited effect in achieving this goal. Since diversion of river flows on a large-scale, as a means of meeting the most critical needs of the system, is not achievable in the near-term there is future opportunity to expand on achieving this particular objective.

7.6.2.1 Environmental operating principles/achieving sustainability

Striving to achieve environmental sustainability is a core objective both for the development and for the implementation of an NER plan. Although the result of the LCA Study effort does not identify the final NER plan, the PBMO is focused on producing economic and environmental outcomes that will support and reinforce one another over both the near and long-term. The recognition of the interdependence of biological resources and the physical and human environment has driven the development of many of the guiding principals and tools applied in this study. As a result, the restoration features and opportunities that make up the PBMO produce balance and synergy between human development activities and natural systems.

The restoration features and opportunities in the PBMO that point toward additional investigations are intended to continue to shape activities and decisions currently under the authority of the USACE in order to increase the continued viability of the natural systems within which they occur. The PBMO is also intended to provide a mechanism to continue to assess and address cumulative impacts to the environment, and to achieve consistency by applying a systems approach to the full life cycle of all related water resources activities in the Louisiana coastal area.

7.6.2.2 Components of the Plan that Best Meets the Objectives (PBMO)

The PBMO consists of the components addressed below. These combined components represent the best near-term approach for addressing coastal wetlands loss in Louisiana. Although the features and opportunities addressed below do not necessarily represent those features and opportunities included in final implementation, the identified restoration features and opportunities represent optimal starting points for the detailed investigations that will lead to project justification and implementation. The projects that are ultimately authorized for construction would be optimized for location, scale, and beneficial output.

7.6.2.2.1 Near-term critical restoration features and opportunities

The first principal component of the PBMO is the group of features and opportunities identified to meet the critical near-term ecosystem needs of the Louisiana coastal wetlands. The restoration features and opportunities representing solutions to the Critical Needs included in the PBMO are:

- MRGO environmental restoration features
- Maurepas Swamp Reintroductions:
    - Small diversion at Hope Canal

- Small diversion at Convent/Blind River
- Increase Amite River Diversion Canal influence by gapping banks

- Barataria Basin barrier shoreline restoration-Caminada Headland, Shell Island
- Small Bayou Lafourche reintroduction
- Medium diversion at Myrtle Grove with dedicated dredging
- Calcasieu River Beneficial Use of Dredge Material
- Modification of Caernarvon Diversion for marsh creation
- Modification of Davis Pond Diversion for marsh creation
- Terrebonne marsh restoration opportunities:
    - Optimize flows and Atchafalaya River influence in Penchant Basin
    - Multi-purpose operation of Houma Navigation Canal (HNC) Lock
    - Convey Atchafalaya River water to Terrebonne marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, enlarging constrictions in the GIWW below Gibson and in Houma and Grand Bayou conveyance channel construction/enlargement
- Terrebonne Basin barrier shoreline restoration-Isles Dernieres, E. Timbalier Island
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Medium diversion at White's Ditch
- Gulf shoreline stabilization at Pt. Au Fer Island
- Lac Des Allemands area Reintroductions:
    - Small diversion at Lac Des Allemands
    - Small diversion at Donaldsonville
    - Small diversion at Pikes Peak
    - Small diversion at Edgard

7.6.2.2.2 Large-scale and long-term concepts requiring detailed study

The second principal component of the PBMO is the identification of large-scale, long-range studies of long-term restoration concepts. These long-range initiatives typically define fundamental changes to the hydrogeomorphic or ecologic structure, function, or management of the Louisiana coast. These concepts, which represent significant opportunities for coastal restoration, require detailed study and development to determine the probable impacts (beneficial and adverse) of such features in order to determine if these projects are desirable and can be integrated into the plan for coastal restoration. These concepts also include some levels of uncertainty, which are typically so extensive in scale that resolution through a demonstration project is impractical. As a general rule, large-scale diversions (flow greater than 15,001 cfs) were deemed impractical in the near-term because of their being mutually exclusive with significant concepts such as Third Delta. River resource hydrodynamic studies would necessarily evaluate these larger scale diversions in concert. The large-scale and long-term concepts identified in the PBMO include:

- Mississippi River Hydrodynamic Study
    - Mississippi River Delta Management Study
    - Third Delta Study

- Will incorporate relevant portions of Upper Atchafalaya Basin Study including evaluation of modified operational scheme of Old River Control Structure *funded under MR&T*
- Acadiana Bay Estuarine Restoration (includes Rebuilding Point Chevreuil Reef)
- Chenier Plain freshwater management and allocation reassessment

7.6.2.2.3 Science and Technology (S&T) Program and potential demonstration projects

The third principal component of the PBMO is the establishment of a S&T Program to address both near and long-term uncertainties in the implementation and execution of the plan. A portion of this component would include the execution of focused demonstration projects to resolve specific uncertainties and provide insight to the programmatic short and long-range implementation of the PBMO.

LOUISIANA COASTAL AREA (LCA), LA - ECOSYSTEM RESTORTATION:

COASTWIDE
ECOSYSTEM RESTORATION STUDY

ATTACHMENT EA-1

Alternatives

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LOUISIANA COASTAL AREA (LCA), LA - ECOSYSTEM RESTORATION: COASTWIDE ECOSYSTEM RESTORATION STUDY

ATTACHMENT EA-1

ALTERNATIVES

TABLE OF CONTENTS

LOUISIANA COASTAL AREA (LCA), LA - ECOSYSTEM RESTORATION: COASTWIDE ECOSYSTEM RESTORATION STUDY

ATTACHMENT 1

ALTERNATIVES

INTRODUCTION

This attachment presents the subprovince alternatives developed for the Louisiana Coastal Area (LCA) Coastwide Ecosystem Restoration Study. Detailed discussions of the first three phases of framework formulation (Phase I = Establish Framework Objectives and Evaluation Criteria; Phase II = Assess Restoration Strategies from the Coast 2050 Plan; and Phase III = Develop and Evaluate Restoration Projects and Features) are contained in this attachment. For the sake of clarity, the information is reiterated within the Main Report and Appendix E about Phase IV = Develop and evaluate Alternatives – Select a Final Array of Coastwide Frameworks. Additionally, a detailed listing of subprovince alternatives and corresponding features is presented. Furthermore, the last portion of this attachment details the Supplemental Framework.

Development of Alternative Frameworks

The subprovince alternative frameworks were established to achieve the Hydrogeomorphic and Ecosystem planning objectives. In addition to establishing a range of possible restoration outcomes, framework scales, by subprovince, were created. The ecological framework scales are based on reduction or reversal of the net annual land loss rate. The scales are defined as follows:

- *No Action (Future Without Project)*: The annual net land loss rate if no additional features are taken to restore coastal Louisiana = -10mi^2/yr
- *Reduce*: The annual net land loss rate is reduced to50 percent of the annual current net land loss rate = -5mi^2/yr
- *Maintain*: There is no net annual loss of land (land gain would equal land loss) = 0 mi^2/yr
- *Increase:* The rate of annual net land gain is 50 percent of the No Action annual net land loss rate = +5 mi^2/yr

Table 1 identifies the Framework Scales by subprovince.

Table 1
Framework Scales by Subprovince

	FWO[1]	Reduce[2]	Maintain[2]	Increase[2]
Subprovince 1	-806 ac/yr	+403 ac/yr	+806 ac/yr	+1,209 ac/yr
Subprovince 2	-2,291 ac/yr	+1,146 ac/yr	+2,291 ac/yr	+3,437 ac/yr
Subprovince 3	-2,842 ac/yr	+1,421 ac/yr	+2,842 ac/yr	+4,263 ac/yr
Subprovince 4	-461 ac/yr	--	+461 ac/yr	+692 ac/yr
Total	-6,400 ac/yr	+2,970 ac/yr	+6,400 ac/yr	+9,601 ac/yr
Total (mi^2/yr)	-10.0	+4.6	+10.0	+15.0

Notes:
1: Numbers for FWO (future without project) are an estimated loss rate, and are subject to change.
2: Numbers for "reduce," "maintain," and "increase" scales are the gross amount of acres restored and/or protected. For net acreage change in any subprovince, the FWO number should be subtracted from the gross acreage protected.

The goal of combining features into subprovince alternatives was to examine different approaches for meeting a specific scale. Thus, the alternative frameworks were intended to represent different hypotheses for ways to meet the various scales. Moreover, the alternatives needed to be distinct enough to provide for a real choice among them. This led to the development of conceptual frameworks and provided for the development of alternatives that are "significantly different." So as to not make the analysis of alternatives overly complex, the number of alternatives for each subprovince scale was limited to three, unless such a limit excluded a reasonable alternative or feature that would not otherwise be reviewed.

Subprovince Frameworks

Subprovince 1 = 10 Alternatives
Subprovince 2 = 10 Alternatives
Subprovince 3 = 5 Alternatives
Subprovince 4 = 7 Alternatives

Subprovinces 1 and 2

Subprovince 1 **(plate 1)** includes Lakes Pontchartrain and Maurepas and the surrounding marshes and swamps. The subprovince extends eastward to the Chandeleur Islands, from the Prairie Terrace on the north, and southward to the Mississippi River. Subprovince 2 **(plate 1)** extends from the Mississippi River on the northeast, to Bayou Lafourche on the west, and to the Gulf of Mexico on the south.

In the initial effort to develop alternatives for Subprovinces 1 and 2, it became evident that there could be three different approaches (or frameworks) for meeting any given scale. Because the fundamental restoration approach for the Deltaic Plain is freshwater and sediment re-introduction, these three conceptual frameworks relate specifically to the design, operation, and ecosystem effects of re-introduction features. The following is a description of each conceptual framework, along with the rationale for its use:

Minimize Salinity Changes: Freshwater re-introductions affect salinity gradients and, therefore, can result in significant ecological changes. Many of the social and economic benefits currently provided by the ecosystem are based on the distribution of marsh types and salinity conditions that have prevailed for several decades. While the long-term goal of freshwater re-introductions is to ensure a healthy, productive, and sustainable coast, such features can change fisheries and wetland habitat types so that local harvesters and communities can no longer realize these benefits. The question then becomes whether it is possible to meet each framework scale in a way that minimizes such potential changes, while still providing for a sustainable coastal ecosystem. To answer this question, one alternative for each scale was developed in a way that seeks to minimize salinity changes. Alternatives consistent with this conceptual framework rely less on freshwater re-introduction and more on marsh creation using external sediment sources (including off-shore and riverine sources). Although the primary features for building marsh platforms are mechanical, limited freshwater re-introductions are included to help ensure the long-term sustainability of existing and restored wetlands. Additionally, the inclusion of freshwater re-introductions would provide an element of self-design, albeit to a relatively limited extent. This framework was applied throughout both subprovinces, but particularly in the upper portion of Subprovince 1, where salinity increases are already recognized as a threat to the ecosystem so reducing salinity was a goal of any alternative for the area.

Continuous Re-introduction (with Stage Variation): In coastal Louisiana, the existing freshwater re-introduction projects (such as Davis Pond and Caernarvon) are for the most part operated with a continuous (i.e., year-round) flow, with discharge volume varying according to river stages and ceasing when river stages are too low. The existing re-introduction projects are relatively small compared to the far larger projects being contemplated in the LCA process to reach the "maintain" and "increase" scales. It is likely that the same approach of year-round re-introduction of water would provide effects at the larger scale that are not apparent with the existing diversions. Moreover, given that the natural deltaic process has been massively disrupted, the existing projects still fall far short of meeting the freshwater, nutrient, and sediment needs of Subprovinces 1 and 2. By developing alternatives around a "continuous re-introduction" framework, the LCA process would be able to assess the potential benefits and costs of using more, and larger re-introductions, that operate year-round. This framework also allows for analysis of the water quality/hypoxia benefits that could be derived from maximum use of freshwater re-introduction.

Mimic Historic Hydrology: Alternatives under this conceptual framework are based on the assumption that historic hydrologic regimes (apart from river switching) in the Deltaic Plain province were characterized by numerous, smaller, seasonal freshwater inflows (from over-bank flow, small distributaries and/or minor crevasses) combined with relatively short-term episodes of large freshwater inflows due to major flood-induced crevasses. Alternatives designed under this framework tend to include numerous, smaller re-introductions combined with large re-introduction projects to be operated in periodic "pulsing" events. Consistent with this framework, the "increase" scale in Subprovince 2 includes the "Third Delta" (to mimic an historic Bayou Lafourche flow), as well as the relocation of navigation on the Mississippi River (to allow for more dynamic deltaic processes at the mouth of the river). Where appropriate, alternatives under this framework also include sediment enrichment of re-introduction waters to mimic the historically higher sediment loads in the Mississippi River. In addition to testing whether mimicking historic hydrology would meet the various scales, this conceptual framework may also provide a way to help restore deltaic processes, while minimizing any potential impacts associated with the year-round re-introduction features discussed above.

Summary of Subprovince 1 and 2

Using these three frameworks would not result in alternatives that are totally different from each other. Indeed, certain features may be included under all or many alternatives for a particular subprovince (e.g., barrier islands in Subprovince 2). Such common elements are often included because they either represent a structural component needed to make an alternative complete or are viewed as being valuable under a variety of scenarios. Moreover, where appropriate and consistent with the given conceptual framework, features were assembled in a way that sought to spread potential benefits throughout each subprovince. For example, though much of the "reduce" scale in Subprovince 1 could potentially be addressed by features taken in the upper portion of the subprovince, the use of such features was limited for the sake of developing alternatives with greater balance and geographic completeness. Finally, in using these frameworks to develop alternatives, care has been taken to ensure that re-introduction projects would not divert too much river flow, which could have consequences for navigation and possibly other existing uses of the river. The same consideration applies to some Subprovince 3 alternatives, as well as to the combination of re-introduction alternatives for all three subprovinces.

Subprovince 3

Subprovince 3 **(plate 1)** encompasses the Terrebonne, Atchafalaya, and Tech-Vermilion Basins. The region extends from Bayou Lafourche on the east, to Freshwater Bayou Canal on the west, and north to the boundary of coastal wetlands.

Environmental and geologic conditions vary considerably across Subprovince 3. The western portion of the subprovince experiences lower subsidence rates than the eastern portion and has the benefit of large volumes of freshwater, sediments, and nutrients flowing down the Atchafalaya River, which results in ongoing deltaic growth. The eastern portion of the subprovince has a far higher land loss rate and has limited opportunities for freshwater re-introduction. The conceptual frameworks for Subprovince 3 reflect both the opportunities and the constraints facing wetland restoration in the area. Specifically, the frameworks represent different approaches to maximizing the use of potential and/or existing freshwater sources, while also restoring important geomorphic features. The conceptual frameworks for Subprovince 3 are:

<u>Maximize Atchafalaya Flow</u>: The ongoing deltaic land growth at the mouth of the Atchafalaya River and Wax Lake Outlet is both a rare source of new wetland acres in coastal Louisiana and a clear example of the benefits that can be derived from restoring deltaic

processes. Alternatives developed under this framework seek to increase, to the maximum extent possible, the ongoing land growth, while also redirecting Atchafalaya River waters to help nourish wetlands in the Terrebonne Basin. In addition to improving natural deltaic processes, alternatives under this framework would involve mechanical features (i.e., sediment delivery) to further expedite and increase land growth. Increased flows down Bayou Lafourche would also be assessed as a means for reducing loss rates in eastern Terrebonne Basin. Finally, as with the other conceptual frameworks for Subprovince 3 (discussed below), alternatives under this framework would include features designed to rehabilitate or maintain important geomorphic features, including barrier islands, land bridges, and gulf shorelines.

Land Building by Delta Development: Given the challenge of reintroducing significant amounts of freshwater, sediments, and nutrients to the eastern portion of Subprovince 3, it would take a massive effort to reestablish deltaic land growth in the area. The only feature potentially capable of this is the “Third Delta,” an ambitious proposal to create a massive new distributary channel from the Mississippi River to both the Barataria and Terrebonne Basins. To assess the effects of such a feature, alternatives developed under this conceptual framework would center on implementation of the “Third Delta”. While relying primarily on this new distributary channel, these alternatives would also include moderate, complementary efforts to increase Atchafalaya Delta development, move Atchafalaya River waters to the east, and restore critical geomorphic features.

Mississippi and Atchafalaya Flows: Alternatives developed under this conceptual framework represent a hybrid of the two former frameworks. Specifically, these alternatives would employ both the “Third Delta”, as well as more extensive efforts to increase Atchafalaya Delta development and move Atchafalaya River waters to the east, while also maximizing efforts to rehabilitate and maintain critical geomorphic features.

Subprovince 4

Subprovince 4 **(plate 1)** extends from the western bank of the Freshwater Bayou Canal westward to the Louisiana/Texas border in Sabine Lake, and from the marsh areas just north of the Gulf Intracoastal Waterway, south to the Gulf of Mexico in Vermilion, Cameron, and Calcasieu Parishes.

Salinity control has been identified as the "keystone strategy" for Subprovince 4. The increased water demands of Texas have also threatened the freshwater inflows that reduce salinity advancement up the Sabine River. With the proposed enlargement of the subprovince's navigation channels, the potential for increases in salinity and losses of vegetative marshes rises. Specifically, the deepening of Calcasieu and Sabine Passes for navigation has been demonstrated to be the primary cause of increased salinity levels, which in turn have resulted in significant impacts to the area's wetland resources. Accordingly, the main conceptual frameworks for alternatives in Subprovince 4 represent different approaches to addressing the fundamental problem of increased salinities. The following is a description of the three conceptual frameworks:

Large-scale Salinity Control: The foundation of alternatives developed under this framework is large-scale salinity control structures (i.e., locks/gates) at Calcasieu Pass and Sabine Pass. Such structures would be designed and operated to improve the salinity increases caused by the deepening of these passes for navigation purposes. While not exactly restoring the historic dimensions of the passes, these structures would have the effect of restricting saltwater inflows, in the same general location that such restrictions existed in the past, with minimum impacts to navigation. Theoretically, implementation of such an alternative could allow for modification or removal of existing upstream salinity control features, thereby supporting the restoration of a more natural and less-managed hydrologic regime throughout the subprovince.

Perimeter Salinity Control: Alternatives developed under this conceptual framework are intended to reduce salinity impacts, while also avoiding any potential effects that locks/gates on the Calcasieu and Sabine Passes may have on navigation. Specifically, this group of alternatives would include small-scale salinity control measures around the perimeters of Calcasieu and Sabine Lakes, thereby reducing saltwater intrusion to adjacent wetlands and waterways. Such structures would be state-of-the-art, designed to minimize disruption of organism and material linkages. However, unlike the large-scale salinity control alternatives, a perimeter approach would likely not limit any increased salinity of the current ecological character and social and economic uses of the Calcasieu and Sabine Passes and Lakes. This alternative would incorporate and build upon existing perimeter control structures.

Freshwater Introduction Salinity Control: Alternatives developed under this conceptual framework rely less on structural salinity-blocking features and more on hydrologic modifications, to bring additional freshwater into the northern portion of the estuaries as the primary means for reducing salinities. Specifically, these alternatives would use culverts and other existing structures as conduits for increased flow of freshwater, which in turn would reduce salinity levels within the Calcasieu and Sabine estuaries. Freshwater introduction across LA Highway 82 in the Mermentau Basin would aide to reduce salinities in the Chenier subbasin. Such alternatives would be intended to aid in the restoration of more natural hydrologic regimes, while having the added benefit of minimizing potential adverse socio-economic impacts associated with the structural approaches considered in the first two frameworks, particularly with respect to the restriction of organism and material linkages and impacts to navigation.

Summary of Subprovince 4

As with the other LCA subprovinces, there are specific features that are common to many of the Subprovince 4 alternatives. For example, as recommended by some members of the National Technical Review Committee (NTRC), beneficial use of material dredged for navigation purposes is included in many Subprovince 4 alternatives. Excessive impoundment of water has been identified as major stressor of the wetlands. Thus, a number of alternatives include features to help reduce excessive water levels, in addition to allowing fresh water to flow southward to higher salinity areas, including the use of structures to improve freshwater flow across LA Highway 82. Finally, as with barrier islands to the east, gulf shoreline stabilization has been included throughout the alternatives in recognition of the critical function served by the Chenier Plain gulf barrier headland.

Features Requiring Further Study

The below features have the potential to significantly influence the coastal ecosystem, resources, or their sustainability and usability. Therefore, these features will be carried forward for further study in conjunction with the selection of a coastwide framework from the final array of coastwide frameworks. The features are as follows:

- Subprovinces 2 and 3 - Third Delta Conveyance Channel Study.
- Subprovince 3 - Modify Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands.
- Subprovinces 1 and 2 - Mississippi Delta Management Study.
- Subprovince 1 - Mississippi River-Gulf Outlet Modification Closure.
- Subprovince 4 - Chenier Plain Freshwater Management and Allocation Reassessment.

SPECIFIC ALTERNATIVES BY SUBPROVINCE

SUBPROVINCE 1 - MISSISSIPPI EAST (BRETON/PONTCHARTRAIN)

This section addresses alternatives for Subprovince 1 with the following scales: (1) reduce, (2) maintain, and (3) increase the amount of wetlands in the subprovince area. There is a total of 10 alternatives for this subprovince: three "reduce" (R); three "maintain" (M); three "increase" (E); and No Action (N).

Subprovince 1	**R1**	**R2**	**R3**	**M1**	**M2**	**M3**	**E1**	**E2**	**E3**	**N1**
15,000 cfs diversion at American / California Bay				X			x	x		
110,000 cfs diversion (div.) at American / California Bay with sediment enrichment			x		x					x
250,000 cfs div. at American / California Bay with sediment enrichment						x			x	
12,000 cfs div. at Bayou Lamoque		x	x		x	x		x	x	x
5,000 cfs div. at Bonnet Carre Spillway	x	x		X						
10,000 cfs div. at Bonnet Carre Spillway						x	x	x	x	
200,000 cfs div. at Caernarvon w/ sediment enrichment								x		
1,000 cfs div. at Convent / Blind River			x			x			x	
5,000 cfs div. at Convent / Blind River		x			x		x			x
10,000 cfs div. at Convent / Blind River								x		
15,000 cfs div. at Fort St. Philip			x	x			x			
26,000 cfs div. at Fort St. Philip w/ sediment enrichment						x				
52,000 cfs div. at Fort St. Philip w/ sediment enrichment									x	
1,000 cfs div. at Hope Canal	x	x	x	x	x	x			x	x
1,000 cfs div at Reserve Relief Canal									x	
6,000 cfs div. at White's Ditch							x			
10,000 cfs div. at White's Ditch		x	x		x	x			x	x
Sediment delivery by pipeline at American/ California Bay				x			x		x	
Sediment delivery via pipeline at Central Wetlands	x			x			x			
Sediment delivery via pipeline at Fort St. Philip				x			x			
Sediment delivery via pipeline at Golden Triangle							x			
Sediment delivery via pipeline at Labranche	x			x			x			x
Sediment delivery via pipeline at Quarantine Bay	x						x			
Authorized opportunistic use of the Bonnet Carre Spillway.										x
Increase Amite River influence by gapping dredged material banks on diversion canals.										x
Marsh nourishment on the New Orleans East land bridge.										x
Mississippi River Delta Management Study.										x
Mississippi River Gulf Outlet Environmental Features and Salinity Control Study.					x		x			x
Reauthorization of the Caernarvon freshwater diversion. (optimize for marsh creation).										x
Rehabilitate Violet Siphon and post authorization change for the diversion. of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands.										x

Note: Gross rates of restored/ protected wetlands: R = Reduce, 406 ac/yr; M = Maintain, 806 ac/yr; E =Increase, -1,209 ac/yr; Scales: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology. Column N1 represents the Supplemental Framework.

Subprovince 1 - Reduce (cut loss by 406 acres per year (ac/yr))

Subprovince 1 - Alternative R1 (Minimize salinity change) – plate 2

Subprovince 1 – Alternative R1 (Minimize salinity change)
1. 1,000 cubic feet per second (cfs) diversion at Hope Canal
2. 5,000 cfs diversion at Bonnet Carre Spillway
3. Sediment delivery via pipeline at Labranche
4. Sediment delivery via pipeline at Central Wetlands
5. Sediment delivery via pipeline at Quarantine Bay

- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cubic feet per second (cfs) diversion at Hope Canal - 1,000 cfs at 50 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, controlled structure (current U.S. Environmental Protection Agency (USEPA) project based on a single box culvert).
- **5,000 cfs diversion at Bonnet Carre spillway**. This feature includes a 5,000 cfs diversion at the Bonnet Carre Spillway with east and west branches into wetlands. 5,000 cfs at 50 percent duration river stage diverted through the existing flood control structure, redirected through the guide levees into adjacent wetlands, annual diversion corresponds to annual river stage hydrograph, with controlled structure(s). At the 5,000 cfs level, the feature may have only one branch.
- **Sediment delivery via pipeline at Labranche Wetlands**. This feature provides for sediment delivery via sediment mined from the Mississippi River. The feature would provide for a dredging volume corresponding to a net yield of approximately 72 wetland acres per year.
- **Sediment delivery via pipeline at Central Wetlands**. This feature provides for sediment delivery via sediment mined from the Mississippi River placed in the Central wetlands adjacent to the Mississippi River Gulf Outlet (MRGO) and Violet canal. The feature would provide for a dredging volume corresponding to a net yield of approximately 92 wetland acres per year.
- **Sediment delivery via pipeline at Quarantine Bay**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River. The feature would provide for a dredging volume corresponding to a net yield of approximately 210 wetland acres per year.

Subprovince 1 - Alternative R2 (Continuous Re-introduction) – plate 3

Subprovince 1 - Alternative R2 (Continuous re-introduction)
1. 5,000 cfs diversion at Convent / Blind River
2. 1,000 cfs diversion at Hope Canal
3. 5,000 cfs diversion at Bonnet Carre Spillway
4. 10,000 cfs diversion at White's Ditch
5. 12,000 cfs diversion at Bayou Lamoque

- **5,000 cfs diversion at Convent / Blind River**. This feature provides for 5,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater, annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at Hope Canal - 1,000 cfs at 50 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, controlled structure (current USEPA project based on a single box culvert).
- **5,000 cfs diversion at Bonnet Carre spillway**. This feature includes a 5,000 cfs diversion at the Bonnet Carre Spillway with east and west branches into wetlands. 5,000 cfs at 50 percent duration river stage diverted through the existing flood control structure, redirected through the guide levees into adjacent wetlands, annual diversion corresponds to annual river stage hydrograph, with controlled structure(s). At the 5,000 cfs level, the feature may have only one branch.
- **10,000 cfs diversion at White's Ditch**. This feature provides for a 10,000 cfs at 50 percent duration river stage into central River aux Chene area, annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs - 12,000 cfs at maximum river stage, annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation, and operational security modifications.

Subprovince 1 - Alternative R3 (Mimic historic Hydrology) – plate 4

Subprovince 1 - Alternative R3 (Mimic Historic Hydrology)
1. 1,000 cfs diversion at Hope Canal
2. 1,000 cfs diversion at Convent / Blind River
3. 10,000 cfs diversion at White's Ditch
4. 12,000 cfs diversion at Bayou Lamoque
5. 110,000 cfs diversion at N American / California Bay with sediment enrichment
6. 15,000 cfs diversion at Fort St. Philip

- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at Hope Canal - 1,000 cfs at 50 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, controlled structure (current USEPA project based on a single box culvert).

- **1,000 cfs diversion at Convent / Blind River**. This feature provides for 1,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater, annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **10,000 cfs diversion at White's Ditch**. This feature provides for a 10,000 cfs diversion at 50 percent duration river stage into central River aux Chene area, annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs. 12,000 cfs at maximum river stage, annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation and operational security modifications.
- **110,000 cfs diversion at Northern American / California Bay with sediment enrichment**. This feature provides for a 110,000 cfs diversion at 50 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 27-inch dredge at capacity for three months. Three month yield = 4,405,000 cubic yards (yd^3) at an average depth of 10 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 245 ppm additional sediment in the diversion at 100,000 cfs
- **15,000 cfs diversion at Fort St. Philip**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage into area north east of fort, annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.

<u>Subprovince 1 - Maintain (cut loss by 806 ac/yr)</u>

<u>Subprovince 1 - Alternative M1 (Minimize salinity change) – plate 5</u>

Subprovince 1 - Alternative M1 (Minimize salinity change)
1. 1,000 cfs diversion at Hope Canal
2. 5,000 cfs diversion at Bonnet Carre Spillway
3. Sediment delivery via pipeline at Labranche
4. Sediment delivery via pipeline at Central Wetlands
5. Sediment delivery via pipeline at American / California Bay
6. 15,000 cfs diversion at American / California Bay
7. Sediment delivery via pipeline at Fort St. Philip
8. 15,000 cfs diversion at Fort St. Philip

- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, controlled structure (current EPA project based on single box culvert).
- **5,000 cfs diversion at Bonnet Carre spillway**. This feature includes a 5,000 cfs diversion at the Bonnet Carre Spillway with east and west branches into wetlands. 5,000 cfs at 50 percent duration river stage diverted through the existing flood control structure, redirected through the guide levees into adjacent wetlands, annual diversion corresponds to annual river stage hydrograph, with controlled structure(s). At the 5,000 cfs level, the feature may have only one branch.

- **Sediment delivery via pipeline at Labranche Wetlands**. This feature provides for sediment delivery via sediment mined from the Mississippi River. The required dredging volume would correspond to a net yield of approximately 72 wetland acres per year.
- **Sediment delivery via pipeline at Central Wetlands**. This feature provides for sediment delivery via sediment mined from the Mississippi River that would be placed in the Central wetlands adjacent to the MRGO and Violet canal. The required dredging volume corresponding to a net yield of approximately 92 wetland acres per year.
- **Sediment delivery via pipeline at American / California Bay**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River. The required dredging volume corresponding to a net yield of approximately 432 wetland acres per year.
- **15,000 cfs diversion at American / California Bay**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Sediment delivery via pipeline at Fort St. Philip**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River, with the required dredging volume corresponding to a net yield of approximately 104 wetland acres per year.
- **15,000 cfs diversion at Fort St. Philip**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage into area north east of the fort. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.

Subprovince 1 - Alternative M2 (Continuous Re-introduction) – plate 6

Subprovince 1 - Alternative M2 (Continuous re-introduction)
1. 5,000 cfs diversion at Convent / Blind River
2. 1,000 cfs diversion at Hope Canal
3. 10,000 cfs diversion at White's Ditch
4. 110,000 cfs diversion at American / California Bay with sediment enrichment
5. 12,000 cfs diversion at Bayou Lamoque
6. Mississippi River Gulf Outlet Environmental Features and Salinity Control Study

- **5,000 cfs diversion at Convent / Blind River**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structure (current EPA project based on single box culvert).
- **10,000 cfs diversion at White's Ditch**. This feature provides for a 10,000 cfs diversion at 50 percent duration river stage into central Riv aux Chene area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **110,000 cfs diversion at American / California Bay with sediment enrichment**. This feature provides for a 110,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to available river stage, uncontrolled diversion. Sediment enrichment assumes use of 24-inch dredge at capacity for three months. Three month yield =2,727, 000 yd^3 at an average depth of 10 feet with 50 percent compaction and 80

percent retention. This corresponds to approximately 138-ppm additional sediment in the diversion at 110,000 cfs.

- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for the refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs - 12,000 cfs at maximum river stage, annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation and operational security modifications.
- **Mississippi River Gulf Outlet Environmental Features and Salinity Control Study.** This restoration feature involves the implementation of the environmental restoration projects contained in the MRGO Study. In response to public concerns, environmental affects and national economic development considerations, an ongoing study is re-evaluating the viability of operation and maintenance of this project. This study would also recommend various environmental restoration projects that would reduce saltwater intrusion into Lake Pontchartrain, the Biloxi marshes, the Central Wetlands, and the Golden Triangle marshes, which has degraded large expanses of freshwater marshes and accelerated habitat switching in these areas.

<u>*Subprovince 1 - Alternative M3 (Mimic historic hydrology) – plate 7*</u>

Subprovince 1 - Alternative M3 (Mimic Historic Hydrology)
1. 1,000 cfs diversion at Convent / Blind River
2. 1,000 cfs diversion at Hope Canal
3. 10,000 cfs diversion at Bonnet Carre Spillway
4. 10,000 cfs diversion at White's Ditch
5. 250,000 cfs diversion at American / California Bay with sediment enrichment
6. 12,000 cfs diversion at Bayou Lamoque
7. 26,000 cfs diversion at Fort St. Philip with sediment enrichment

- **1,000 cfs diversion at Convent / Blind River**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structure (current EPA project based on single box culvert).
- **10,000 cfs diversion at Bonnet Carre spillway**. This feature consists of a 10,000 cfs diversion with east and west branches into wetlands - 10,000 cfs at 50 percent duration river stage diverted through the existing flood control structure – redirected through the guide levees into adjacent wetlands. Annual diversion corresponds to annual river stage hydrograph, with controlled structures.
- **10,000 cfs diversion at White's Ditch**. This feature provides for a 10,000 cfs diversion at 50 percent duration river stage into central River aux Chene area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **250,000 cfs diversion at Northern American / California Bay with sediment enrichment**. This feature provides for a 250,000 cfs diversion at 70 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, uncontrolled

diversion. Sediment enrichment assumes use of 30-inch dredge at capacity for three months. Three month yield = 6,293, 000 yd^3 at an average depth of 10 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 140-ppm additional sediment in the diversion at 250,000 cfs.

- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs - 12,000 cfs at maximum river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation and operational security modifications.
- **26,000 cfs diversion at Fort St. Philip with sediment enrichment**. This feature provides for a 26,000 cfs diversion at 50 percent duration river stage into area north east of the fort. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 16-inch dredge at capacity for three months. Three month yield = 1,154, 000 yd^3 at an average depth of 7.5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 247 ppm additional sediment in the diversion at 26,000 cfs

<u>Subprovince 1 - Increase (cut loss by 1,209 ac/yr)</u>

<u>Subprovince 1 - Alternative E1 (Minimize salinity change) – plate 8</u>

Subprovince 1 - Alternative E1 (Minimize salinity change)
1. 5,000 cfs diversion at Convent / Blind River
2. 10,000 cfs diversion at Bonnet Carre Spillway
3. Sediment delivery via pipeline at Labranche
4. Sediment delivery via pipeline at Golden Triangle
5. Sediment delivery via pipeline at Central Wetlands
6. 6,000 cfs diversion at White's Ditch
7. Sediment delivery via pipeline at American / California Bay
8. Sediment delivery via pipeline at Quarantine Bay
9. Sediment delivery via pipeline at Fort St. Philip
10. 15,000 cfs diversion at American / California Bay
11. 15,000 cfs diversion at Fort St. Philip
12. Mississippi River Gulf Outlet Environmental Features and Salinity Control Study

- **5,000 cfs diversion at Convent / Blind River**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **10,000 cfs diversion at Bonnet Carre spillway**. This feature consists of a 10,000 cfs diversion with east and west branches into wetlands - 10,000 cfs at 50 percent duration river stage diverted through the existing flood control structure – redirected through the guide levees into adjacent wetlands. Annual diversion corresponds to annual river stage hydrograph, with controlled structures.

- **Sediment delivery via pipeline at Labranche Wetlands**. This feature provides for sediment delivery via sediment mined from the Mississippi River. Required dredging volume corresponding to a net yield of approximately 72 wetland acres per year.
- **Sediment delivery via pipeline at Golden Triangle Area**. This feature provides for sediment delivery via sediment mined from the Mississippi River placed in the area formed by the confluence of the MRGO and Gulf Intracoastal Waterway (GIWW) and Lake Borgne. Required dredging volume corresponding to a net yield of approximately 72 wetland acres per year.
- **Sediment delivery via pipeline at Central Wetlands**. This feature provides for sediment delivery via sediment mined from the Mississippi River placed in the Central wetlands adjacent to the MRGO and Violet canal. Required dredging volume corresponding to a net yield of approximately 92 wetland acres per year.
- **6,000 cfs diversion at White's Ditch**. This feature provides for a 6,000 cfs diversion at 50 percent duration river stage into central River aux Chene area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **Sediment delivery via pipeline at American / California Bay**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River, with the required dredging volume corresponding to a net yield of approximately 432 wetland acres per year.
- **Sediment delivery via pipeline at Quarantine Bay**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River, with the required dredging volume corresponding to a net yield of approximately 391 wetland acres per year.
- **Sediment delivery via pipeline at Fort St. Philip**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River. Required dredge volume corresponding to a net yield of approximately 104 wetland acres per year.
- **15,000 cfs diversion at American / California Bay**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **15,000 cfs diversion at Fort St. Philip**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage into area north east of fort. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Mississippi River Gulf Outlet Environmental Features and Salinity Control Study.** This restoration feature involves the implementation of the environmental restoration projects contained in the MRGO Study. In response to public concerns, environmental affects and national economic development considerations, an ongoing study is re-evaluating the viability of operation and maintenance of this project. This study would also recommend various environmental restoration projects that would reduce saltwater intrusion into Lake Pontchartrain, the Biloxi marshes, the Central Wetlands, and the Golden Triangle marshes, which has degraded large expanses of freshwater marshes and accelerated habitat switching in these areas.

Subprovince 1 - Alternative E2 (Continuous Re-introduction) – plate 9

Subprovince 1 - Alternative E2 (Continuous re-introduction)
1. 10,000 cfs diversion at Convent / Blind River
2. 10,000 cfs diversion at Bonnet Carre Spillway
3. 200,000 cfs diversion at Caernarvon with sediment enrichment
4. 15,000 cfs diversion at American / California Bay
5. 12,000 cfs diversion at Bayou Lamoque

- **10,000 cfs diversion at Convent / Blind River**. This feature provides for a 10,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **10,000 cfs diversion at Bonnet Carre spillway**. This feature consists of a 10,000 cfs diversion with east and west branches into wetlands - 10,000 cfs at 50 percent duration river stage diverted through the existing flood control structure – redirected through the guide levees into adjacent wetlands. Annual diversion corresponds to annual river stage hydrograph, with controlled structures.
- **200,000 cfs Delta building diversion at Caernarvon with sediment enrichment**. This feature provides for a 200,000 cfs diversion at 70 percent duration river stage channeled into northeastern Breton basin. Annual diversion corresponds to available river stage, controlled structure.
- **15,000 cfs diversion at American / California Bay**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs - 12,000 cfs at maximum river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation and operational security modifications.

Subprovince 1 - Alternative E3 (Mimic historic hydrology) – plate 10

Subprovince 1 - Alternative E3 (Mimic Historic Hydrology)
1. 1,000 cfs diversion at Convent / Blind River
2. 1,000 cfs diversion at Hope Canal
3. 1,000 cfs diversion at Reserve Relief Canal
4. 10,000 cfs diversion at Bonnet Carre Spillway
5. 10,000 cfs diversion at White's Ditch
6. 250,000 cfs diversion at American / California Bay with sediment enrichment
7. 12,000 cfs diversion at Bayou Lamoque
8. 52,000 cfs diversion at Fort St. Philip with sediment enrichment
9. Sediment delivery by pipeline at American / California Bay

- **1,000 cfs diversion at Convent / Blind River**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structure (current EPA project based on single box culvert).
- **1,000 cfs diversion at Reserve Relief Canal**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into the southeastern Maurepas swamp. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **10,000 cfs diversion at Bonnet Carre spillway**. This feature consists of a 10,000 cfs diversion with east and west branches into wetlands - 10,000 cfs at 50 percent duration river stage diverted through the existing flood control structure – redirected through the guide levees into adjacent wetlands, annual diversion corresponds to annual river stage hydrograph, with controlled structures.
- **10,000 cfs diversion at White's Ditch**. This feature provides for a 10,000 cfs diversion at 50 percent duration river stage into central River aux Chene area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **250,000 cfs diversion at American / California Bay with sediment enrichment.** This feature provides for a 250,000 cfs diversion at 70 percent duration river stage, annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 30-inch dredge at capacity for three months. Three month yield = 6,293, 000 yd^3 at an average depth of 10 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 140 ppm additional sediment in the diversion at 250,000 cfs
- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs - 12,000 cfs at maximum river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation and operational security modifications.
- **52,000 cfs diversion at Fort St. Philip with sediment enrichment**. This feature provides for a 52,000 cfs diversion at 50 percent duration river stage into area north east of fort, annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 16-inch dredge at capacity for three months. Three month yield = 1,154, 000 yd^3 at an average depth of 7.5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 123-ppm additional sediment in the diversion at 52,000 cfs.
- **Sediment delivery via pipeline at American / California Bay**. This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River, with the required dredging volume corresponding to a net yield of approximately 432 wetland acres per year.

SUBPROVINCE 2 -MISSISSIPPI WEST (BARATARIA)

This section would address alternatives for Subprovince two with the following scales: (1) reduce, (2) maintain and (3) increase the amount of wetlands in the Subprovince area. There is a total of ten alternatives for this subprovince: three "reduce" (R); three "maintain" (M); three "increase"(E); and No Action (N).

Subprovince 2	**R1**	**R2**	**R3**	**M1**	**M2**	**M3**	**E1**	**E2**	**E3**	**N1**
5,000 cfs diversion (div.) at Bastian Bay/Buras			x							
130,000 cfs div. at Bastian Bay/Buras		x								
120,000 cfs div. near Bayou Lafourche									x	
60,000 cfs div. at Boothville w/ sediment enrichment.										x
1,000 cfs div. at Donaldsonville		x	x		x	x				x
5,000 cfs div. at Donaldsonville w/ sediment enrichment								x		
1,000 cfs div. at Edgard		x	x		x	x				x
5,000 cfs div. at Edgard w/ sediment enrichment	x							x		
5,000 cfs div. at Empire			x							
90,000 cfs div. at Empire								x		
5,000 cfs div. at Fort Jackson			x							
60,000 cfs div. At Fort Jackson	x			x						
60,000 cfs div. at Fort Jackson w/ sediment enrichment						x	x	x		
90,000 cfs div. at Fort Jackson w/ sediment enrichment									x	
150,000 cfs div. at Fort Jackson w/ sediment enrichment					x					
1,000 cfs div. at Lac des Allemands		x			x	x				x
5,000 cfs div. at Lac des Allemands w/ sediment enrichment				x			x	x	x	
5,000 cfs div. at Myrtle Grove	x		x	x			x			x
15,000 cfs div. at Myrtle Grove		x								
38,000 cfs div. at Myrtle Grove w/ sediment enrichment					x					
75,000 cfs div. at Myrtle Grove w/ sediment enrichment						x				
150,000 cfs div. at Myrtle Grove w/ sediment enrichment								x		
5,000 cfs div at Oakville			x							
1,000 cfs div. at Pikes Peak		x	x		x	x				x
5,000 cfs div. at Pikes Peak w/ sediment enrichment								x		
5,000 cfs div. at Port Sulphur			x							
Barrier Island restoration at Barataria Shoreline	x	x	x	x	x	x	x	x	x	x
Marsh creation at Wetland Creation and Restoration feasibility study sites	x			x			x		x	x
Mississippi River Delta Management Study.										x
Reauthorization of Davis Pond.										x
Relocation of Deep Draft Navigation Channel							x		x	
Sediment delivery via pipeline at Bastian Bay / Buras				x			x			
Sediment delivery via pipeline at Empire			x	x			x			
Sediment delivery via pipeline at Main Pass (Head of Passes)				x			x			
Sediment delivery via pipeline at Myrtle Grove	x			x			x			x
Third Delta Study										x

Note: Gross rates of restored/ protected wetlands: R = Reduce 1,146 ac/yr; M = Maintain, 2,291 ac/yr ; E = Increase, 3,436 ac/yr; Scales: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology. Column N1 represents the Supplemental Framework.

Subprovince 2 - Reduce (cut loss by 1,146 ac/yr.)

Subprovince 2 - Alternative R1 (Minimize salinity change) – plate 11

Subprovince 2 - Alternative R1 (Minimize salinity change)
1. 5,000 cfs diversion at Edgard with sediment enrichment
2. Sediment via pipeline at Myrtle Grove
3. 5,000 cfs diversion at Myrtle Grove
4. Marsh creation at Wetland Creation and Restoration feasibility study sites
5. Barrier Islands restoration at Barataria Shoreline
6. 60,000 cfs diversion at Fort Jackson

- **5,000 cfs diversion at Edgard with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day)
- **Sediment delivery via pipeline at Myrtle Grove**. This feature provides for sediment delivery via sediment mined from Mississippi River. Required dredging volume corresponding to a net yield of approximately 29 wetland acres per year.
- **5,000 cfs diversion at Myrtle Grove**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **Marsh creation at Wetland Creation and Restoration Feasibility Study sites**. Sediment mined from offshore borrow sites placed in the sites along Bayou Lafourche. Required dredging volume corresponding to a net yield of approximately 360 wetland acres per year.
- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island width footprint.
- **60,000 cfs diversion at Fort Jackson**. This feature provides for a 60,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.

<u>Subprovince 2 - Alternative R2 (Continuous Re-introduction) – plate 12</u>

Subprovince 2 - Alternative R2 (Continuous Re-introduction)
1. 1,000 cfs diversion at Lac des Allemands
2. 1,000 cfs diversion at Donaldsonville
3. 1,000 cfs diversion at Pikes Peak
4. 1,000 cfs diversion at Edgard
5. 15,000 cfs diversion at Myrtle Grove
6. 130,000 cfs diversion at Bastian Bay/Buras
7. Barrier Island restoration at Barataria Shoreline

- **1,000 cfs diversion at Lac des Allemands**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Becnel. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Donaldsonville**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into upper Bayou Verret. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Pikes Peak**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Bayou Chevreuil. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Edgard**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **15,000 cfs diversion at Myrtle Grove**. This feature provides for a 15,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **130,000 cfs diversion at Bastian Bay / Buras**. This feature provides for a 130,000 cfs diversion at 50 percent duration river stage into Bastian Bay. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 1,500-foot island width footprint.

Subprovince 2 - Alternative R3 (Mimic historic hydrology) – plate 13

Subprovince 2 - Alternative R3 (Mimic Historic Hydrology)
1. 1,000 cfs diversion at Donaldsonville
2. 1,000 cfs diversion at Pikes Peak
3. 1,000 cfs diversion at Edgard
4. 5,000 cfs diversion at Oakville
5. 5,000 cfs diversion at Myrtle Grove
6. 5,000 cfs diversion at Port Sulphur
7. 5,000 cfs diversion at Empire
8. 5,000 cfs diversion at Bastian Bay/Buras
9. 5,000 cfs diversion at Fort Jackson
10. Sediment delivery via pipeline at Empire
11. Barrier Island restoration at Barataria Shoreline

- **1,000 cfs diversion at Donaldsonville**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into upper Bayou Verret. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Pikes Peak**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Bayou Chevreuil. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Edgard**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **5,000 cfs diversion at Oakville**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Concession. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **5,000 cfs diversion at Myrtle Grove**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area four out of five years. Operate at 150,000 cfs every fifth year. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **5,000 cfs diversion at Port Sulphur**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Freeport Sulphur canal. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **5,000 cfs diversion at Empire**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Bay Adams. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **5,000 cfs diversion at Bastian Bay / Buras**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the open wetlands. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **5,000 cfs diversion at Fort Jackson**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Sediment delivery via pipeline at Empire**. This feature provides for sediment delivery via sediment mined from the Mississippi River placed in Bay Adams. Required dredge volume corresponding to a net yield of approximately 115 wetland acres per year.

- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island width footprint.

Subprovince 2 -Maintain (cut loss by 2,291 ac/yr.)

Subprovince 2 - Alternative M1 (Minimize salinity change) – plate 14

Subprovince 2 - Alternative M1 (Minimize salinity change)
1. 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2. Sediment delivery via pipeline at Myrtle Grove
3. 5,000 cfs diversion at Myrtle Grove
4. Barrier Island restoration at Barataria Shoreline
5. 60,000 cfs diversion at Fort Jackson
6. Sediment delivery via pipeline at Empire
7. Sediment delivery via pipeline at Bastian Bay
8. Sediment delivery via pipeline at Main Pass (Head of Passes)
9. Marsh Creation at Wetland Creation and Restoration feasibility study sites

- **5,000 cfs diversion at Lac des Allemands with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inchdredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).
- **Sediment delivery via pipeline at Myrtle Grove**. This feature provides for sediment delivery via sediment mined from the Mississippi River. Required dredging volume corresponding to a net yield of approximately 130 wetland acres per year.
- **5,000 cfs diversion at Myrtle Grove**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island width footprint.
- **60,000 cfs diversion at Fort Jackson**. This feature provides for a 60,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Sediment delivery via pipeline at Empire**. This feature provides for sediment delivery via sediment mined from Mississippi River placed in Bay Adams. Required dredging volume corresponding to a net yield of approximately 115 wetland acres per year.
- **Sediment delivery via pipeline at Bastian Bay / Buras**. This feature provides for sediment delivery via sediment mined from the Mississippi River placed in Bastian Bay.

Required dredging volume corresponding to a net yield of approximately 48 wetland acres per year.

- **Sediment delivery via pipeline at Main Pass (Head of Passes).** This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River utilizing a Sediment Trap above the Head of Passes. Estimated dredging volume nine million cubic yards per year corresponding to a net yield of approximately 1,017 wetland acres per year.
- **Marsh creation at Wetland Creation and Restoration Feasibility Study sites**. This feature provides for sediment delivery via sediment mined from offshore borrow sites placed in the sites along Bayou Lafourche, required dredging volume corresponding to a net yield of approximately 180 wetland acres per year.

Subprovince 2 - Alternative M2 (Continuous Re-introduction) – plate 15

Subprovince 2 - Alternative M2 (Continuous Re-introduction)
1. 1,000 cfs diversion at Lac des Allemands
2. 1,000 cfs diversion at Donaldsonville
3. 1,000 cfs diversion at Pikes Peak
4. 1,000 cfs diversion at Edgard
5. 38,000 cfs diversion at Myrtle Grove with sediment enrichment
6. 150,000 cfs diversion at Fort Jackson with sediment enrichment
7. Barrier Island restoration at Barataria Shoreline

- **1,000 cfs diversion at Lac des Allemands**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Becnel. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Donaldsonville**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into upper Bayou Verret. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Pikes Peak**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Bayou Chevreuil. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Edgard**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier. Annual diversion corresponds to annual river stage hydrograph, controlled structure
- **38,000 cfs diversion at Myrtle Grove with sediment enrichment**. This feature provides for a 38,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 20-inch dredge at capacity for three months. Three month yield = 1,468, 000 yd^3 at an average depth of 5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 215-ppm additional sediment in the diversion at 38,000 cfs.
- **150,000 cfs diversion at Fort Jackson with sediment enrichment**. This feature provides for a 150,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage

hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 30-inch dredge at capacity for 3 months. Three month yield = 6,293, 000 yd^3 at an average depth of 7.5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 233-ppm additional sediment in the diversion at 150,000 cfs.

- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 1,500-foot island width footprint.

Subprovince 2 - Alternative M3 (Mimic historic hydrology) – plate 16

Subprovince 2 - Alternative M3 (Mimic Historic Hydrology)
1. 1,000 cfs diversion at Lac des Allemands
2. 1,000 cfs diversion at Donaldsonville
3. 1,000 cfs diversion at Pikes Peak
4. 1,000 cfs diversion at Edgard
5. 75,000 cfs diversion at Myrtle Grove with sediment enrichment
6. 60,000 cfs at Fort Jackson with sediment enrichment
7. Barrier Island restoration at Barataria Shoreline

- **1,000 cfs diversion at Lac des Allemands**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Becnel. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Donaldsonville**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into upper Bayou Verret. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Pikes Peak**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Bayou Chevreuil. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Edgard**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **75,000 cfs diversion at Myrtle Grove with sediment enrichment.** This feature provides for a 75,000 cfs diversion at 50 percent duration river stage diverted for three months at five-year intervals. Diversion corresponds to available river stage hydrograph. Bonnet Carre type controlled structure. Sediment enrichment assumes use of 30-inch dredge at capacity for three-months. Three month yield = 6,293, 000 yd^3 at an average depth of 5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 466-ppm additional sediment in the diversion at 75,000 cfs.
- **60,000 cfs diversion at Fort Jackson with sediment enrichment**. This feature provides for a 60,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island footprint.

Subprovince 2 -Increase (cut loss by 3,436 ac/yr.)

Subprovince 2 - Alternative E1 (Minimize salinity change) – plate 17

Subprovince 2 - Alternative E1 (Minimize salinity change)
1. 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2. Sediment delivery via pipeline at Myrtle Grove
3. 5,000 cfs diversion at Myrtle Grove
4. Marsh creation at Marsh creation feasibility study sites
5. Sediment delivery via pipeline at Empire
6. Sediment delivery via pipeline at Bastian Bay/Buras
7. Sediment delivery via pipeline at Main Pass (Head of Passes)
8. 60,000 cfs diversion at Fort Jackson with sediment enrichment
9. Relocation of Deep Draft Navigation Channel
10. Barrier Island restoration at Barataria Shoreline

- **5,000 cfs diversion at Lac des Allemands with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).
- **Sediment delivery via pipeline at Myrtle Grove**. This feature provides for sediment delivery via sediment mined from the Mississippi River. Required dredging volume corresponding to a net yield of approximately 130 wetland acres per year.
- **5,000 cfs diversion at Myrtle Grove**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **Marsh creation at Wetland Creation and Restoration Feasibility Study sites**. Sediment mined from Mississippi River placed in the sites along Bayou Lafourche, required dredging volume corresponding to a net yield of approximately 220 wetland acres per year.
- **Sediment delivery via pipeline at Empire**. This feature provides for sediment delivery via sediment mined from Mississippi River placed in Bay Adams. Required dredging volume corresponding to a net yield of approximately 115 wetland acres per year.
- **Sediment delivery via pipeline at Bastian Bay / Buras**. This feature provides for sediment delivery via sediment mined from Mississippi River placed in Bastian Bay. Required dredging volume corresponding to a net yield of approximately 48 wetland acres per year.
- **Sediment delivery via pipeline at Main Pass (Head of Passes).** This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River utilizing a Sediment Trap above the Head of Passes. Estimated dredging volume nine

million cubic yards per year corresponding to a net yield of approximately 1,017 wetland acres per year.

- **60,000 cfs diversion at Fort Jackson with sediment enrichment.** This feature provides for a 60,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 20-inch dredge at capacity for three months. Three month yield = 1,468, 000 yd^3 at an average depth 7.5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 136-ppm additional sediment in the diversion at 60,000 cfs.
- **Relocation of Deep Draft Navigation Channel**. This feature provides for relocation of main navigation channel away from Southwest Pass. Would require the construction of sail through locks and new 45-foot draft channel. Maintenance of Southwest pass would be continued at 35-foot draft. Reconfiguration of navigation system would result in increases in stage durations in the upper portion of the hydrograph causing more frequent overflow of the Mississippi River Delta and greater availability of river flow for diversion at upriver locations. Increased stages in Southwest pass are due to the decrease in cross-sectional area (45-foot draft to 35-foot draft).
- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island footprint.

Subprovince 2 - Alternative E2 (Continuous Re-introduction) – plate 18

Subprovince 2 - Alternative E2 (Continuous Re-introduction)
1. 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2. 5,000 cfs diversion at Pikes Peak with sediment enrichment
3. 5,000 cfs diversion at Edgard with sediment enrichment
4. 5,000 cfs diversion at Donaldsonville with sediment enrichment
5. 150,000 cfs diversion at Myrtle Grove with sediment enrichment
6. 90,000 cfs diversion at Empire
7. 60,000 cfs diversion at Fort Jackson with sediment enrichment
8. Barrier Island restoration at Barataria Shoreline

- **5,000 cfs diversion at Lac des Allemands with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).
- **5,000 cfs diversion at Pikes Peak with sediment enrichment.** This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Bayou Chevreuil. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine

sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).

- **5,000 cfs diversion at Edgard with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier, annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).
- **5,000 cfs diversion at Donaldsonville with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into upper Bayou Verret. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).
- **150,000 cfs diversion at Myrtle Grove with sediment enrichment**. This feature provides for a 150,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 30-inch dredge at capacity for three months. Three month yield = 6,293, 000 yd^3 at an average depth of 5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 233-ppm additional sediment in the diversion at 150,000 cfs.
- **90,000 cfs diversion at Empire**. This feature provides for a 90,000 cfs diversion at 50 percent duration river stage diverted into Bay Adams. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **60,000 cfs diversion at Fort Jackson with sediment enrichment**. This feature provides for a 60,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 20-inch dredge at capacity for three months. Three month yield = 1,468, 000 yd^3 at an average depth of 7.5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 136-ppm additional sediment in the diversion at 60,000 cfs.
- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island footprint.

<u>Subprovince 2 - Alternative E3 (Mimic historic hydrology) – plate 19</u>

Subprovince 2 - Alternative E3 (Mimic Historic Hydrology)
1. 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2. 120,000 cfs diversion near Bayou Lafourche (Mississippi River Third Delta)
3. Marsh creation at Marsh creation feasibility study sites
4. 90,000 cfs diversion at Fort Jackson with sediment enrichment
5. Relocation of Deep Draft Navigation Channel
6. Barrier Island restoration at Barataria Shoreline

- **5,000 cfs diversion at Lac des Allemands with sediment enrichment**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands. Annual diversion corresponds to annual river stage hydrograph, controlled structure. Sediment enrichment assumes use of 12-inch dredge for three months. Discharge of effluent up stream of the diversion intake would allow the capture of silts and very fine sands only. This would result in capture of approximately 30 percent of the total dredge effluent (6,989 yd^3 / day).
- **120,000 cfs diversion at Bayou Lafourche (Mississippi River Third Delta).** This feature provides for a 120,000 cfs diversion at Bayou Lafourche. Approximately 240,000 cfs at maximum river stage diverted into a newly constructed conveyance channel (parallel to Bayou Lafourche), diversion corresponds to annual river stage hydrograph, diverted flow would be divided equally between the Barataria and Terrebonne hydrologic basins, controlled structure. Sediment enrichment assumes use of 30-inch dredge at capacity for three months. Three month yield = 6,293, 000 yd^3 at an average depth of 5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 175-ppm additional sediment in the diversion at 200,000 cfs.
- **Marsh creation at Wetland Creation and Restoration Feasibility Study sites**. Sediment mined from Mississippi River placed in the sites along Bayou Lafourche, required dredging volume corresponding to a net yield of approximately 220 wetland acres per year.
- **90,000 cfs diversion at Fort Jackson with sediment enrichment.** This feature provides for a 90,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion. Sediment enrichment assumes use of 24-inch dredge at capacity for three months. Three month yield = 2,727, 000 yd^3 at an average depth of 7.5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 168-ppm additional sediment in the diversion at 90,000 cfs.
- **Relocation of Deep Draft Navigation Channel**. This feature provides for the relocation of main navigation channel away from Southwest Pass. Would require the construction of sail through locks and new 45-foot draft channel. Maintenance of Southwest pass would be continued at 35-foot draft. Reconfiguration of navigation system would result in increases in stage durations in the upper portion of the hydrograph causing more frequent overflow of the Mississippi River Delta and greater availability of river flow for diversion at upriver locations. Increased stages in Southwest pass are due to the decrease in cross-sectional area (45-foot draft to 35-foot draft).

- **Barrier Island restoration at Barataria Shoreline**. Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island footprint.

SUBPROVINCE 3 - TERREBONNE, ATCHAFALAYA AND TECHE / VERMILLION

This section would address alternatives for Subprovince 3 with the following scales: (1) reduce and (2) maintain. There is a total of ten alternatives for this subprovince: three "reduce" (R); one "maintain" (M); and No Action (N).

Subprovince 3	R1	R2	R3	M1						N1
Backfill pipeline canals			x	x						
Bayou Lafourche 1,000 cfs pump	x	x		x						x
Convey Atchafalaya River water to Terrebonne marshes	x		x	x						x
Freshwater introduction south of Lake Decade	x	x		x						
Freshwater introduction via Blue Hammock Bayou	x	x		x						x
Increase sediment transport down Wax Lake Outlet	x	x		x						x
Maintain land bridge between Bayous Dularge and Grand Caillou	x		x	x						x
Maintain land bridge between Caillou Lake and Gulf of Mexico.			x	x						x
Maintain northern shore of East Cote Blanche Bay at Pt. Marone			x	x						x
Maintain Timbalier land bridge			x	x						
Multipurpose operation of the Houma Navigation Canal (HNC) Lock.	x	x	x	x						x
Penchant Basin Plan	x	x	x	x						x
Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island	x	x	x	x						
Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west	x	x	x	x						
Rebuild Point Chevreuil Reef			x	x						x
Rehabilitate northern shorelines of Terrebonne/Timbalier Bays			x	x						
Relocate the Atchafalaya navigation channel	x	x		x						x
Restore Terrebonne barrier islands.			x	x						x
Stabilize banks of Southwest Pass			x	x						
Stabilize gulf shoreline of Point Au Fer Island			x	x						x
Study the modification of the Old River Control Structure (ORCS) Operational Scheme to Benefit Coastal Wetlands	x	x		x						x
Third Delta (120,000 cfs diversion)		x		x						

Note: Gross rates of restored/ protected wetlands: R = Reduce, 1,421 ac/yr; M = Maintain, 2,842 ac/yr; Scales: 1 = Maximize Atchafalaya (NIC 3rd Delta); 2 = Land-building by delta development; 3 = Mississippi and Atchafalaya flows. Column N1 represents the Supplemental Framework.

Subprovince 3 – Reduce Alternatives (cut loss by 1,421 ac/yr.)

Subprovince 3 - Alternative R1 (Maximize Atchafalaya Flow) – plate 20

Subprovince 3 - Alternative R1 (Maximize Atchafalaya Flow (does not include Third Delta)
1. Bayou Lafourche 1,000 cfs pump
2. Convey Atchafalaya River water to Terrebonne marshes
3. Freshwater introduction via Blue Hammock Bayou
4. Freshwater introduction south of Lake Decade
5. Penchant Basin Plan
6. Relocate the Atchafalaya navigation channel
7. Increase sediment transport down Wax Lake Outlet
8. Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene
9. Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
10. Study the modification of the Old River Control Structure (ORCS) Operational Scheme to Benefit Coastal Wetlands
11. Multi-purpose operation of the Houma Navigation Canal Lock (HNC)
12. Maintain land bridge between Bayous Dularge and Grand Caillou

- **Bayou Lafourche 1,000 cfs pump.** A flow of 1000 CFS would be pumped into Bayou Lafourche. The targeted wetland benefit area is the area between Bayous Lafourche and Terrebonne, south of the GIWW. The flow would be continuous and would freshen the wetlands and would reduce loss rates.
- **Convey Atchafalaya River water to Terrebonne marshes.** Increase Atchafalaya River flows to Terrebonne Basin by a diversion in the Avoca Island Levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma. Ideally, half of Bayou Shaffer flow, or more, would be diverted (via an open unstructured cut through the levee) into Avoca Lake to maximize land building. The percent flow diverted would be reduced if high water level impacts in the Penchant marshes would be too great. A constriction structure in Bayou Shaffer would be installed downstream of the levee cut to force flow into Avoca Lake. Several new channels connecting the eastern portions of Avoca Lake with Bayou Chene would be constructed to facilitate the distribution of sediments (land-building) across a wider portion of the lake bottom. Introduced flows leaving Avoca Lake would be readily carried southward down Bayou Penchant, increasing its sediment load, compared to the existing conditions where water has to back-up to Bayou Penchant through the Avoca Island Cutoff Channel. In lieu of a diversion from Bayou Shaffer into Avoca Lake, an alternative might be to partial or fully breach the Avoca Island Extension Levee where Bayou Shaffer runs adjacent to the Avoca Island Cutoff Canal. This cut would also involve an open armored channel.

In conjunction with the Bayou Shaffer diversion, sections of eroded dredged material banks along the GIWW would be repaired to contain flows for more efficient delivery to areas of need further east and to halt boat wake-induced erosion of shoreline marshes.

In conjunction with the above features, and to better carry water eastward to brackish areas of need, the GIWW constrictions would be enlarged. In Bayou Chene, the channel is roughly 12,000 sq. feet. But between Bayou Black and Bay Wallace, the channel is reduced to 5,500 sq. feet. The most severe constriction is in Houma where cross-section is reduced to as little as 2,200 sq. feet at the Bayou Terrebonne junction. An initial concept is to construct and maintain an 8,000 sq. foot channel through Houma. This concept is very closely linked with project number 5a above and would be considered only if that project shows that the presently available freshwater can be fully utilized through features to introduce it into needy marshes south of the GIWW. This project would involve dredging to enlarge channel cross-section and relocations of businesses and utilities, together with bridge modifications as needed. The Houma GIWW tunnel may limit the degree to which the channel can be enlarged at the tunnel location.

- **Freshwater introduction via Blue Hammock Bayou.** Increase Atchafalaya Flow to SW Terrebonne via Blue Hammock Bayou. The project would increase the distribution of Atchafalaya flows in Fourleague Bay to Lake Merchant wetlands by increasing the cross-section of Blue Hammock Bayou. Marsh would be created with material dredged. Grand Pass and Buckskin Bayou, the outlets of Lake Merchant, would be reduced in cross section to increase the retention of Atchafalaya nutrients, sediment, and freshwater.
- **Freshwater introduction south of Lake Decade.** Enhance Atchafalaya flows to Terrebonne by constructing three small conveyance channels along the south shore of Lake Decade to the Small Bayou LaPointe area. Construct three conveyance channels along the south shore of Lake Decade to deliver Atchafalaya flows to wetlands between the lake, Bayou Dularge, and Lake Merchant. Channel flows would be controlled by structures that could be actively operated. Intermediate marsh losses would be reduced by lowering salinities and increasing nutrient inputs.
- **Penchant Basin Plan.** Reduce excessive water levels in the upper Penchant Subbasin by implementing the Penchant Basin Plan. The Penchant Basin Plan would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods. Increased outlet capacities would utilize the flows to increase the circulation and retention to wetlands in the more tidal zone below the large fresh floating marsh zone. Wetlands losses would be reduced in both zones (Louisiana State University (LSU) Controlled Ecological Life Support System (CELSS) model results).
- **Relocate the Atchafalaya navigation channel.** This feature consists of relocating the Atchafalaya navigation channel. The Navigation Channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the Channel and using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the delta lobes.
- **Increase sediment transport down Wax Lake Outlet.** Increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet (WLO) flows pass over the relatively shallow Six Mile Lake before entering the outlet. This feature

would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby increasing more bed load sediments to be transported to the WLO delta. Increased delta growth was projected by the LSU CELSS Western Bays Model.

- **Rebuild Historic Reefs - Rebuild historic barrier between Point Au Fer and Eugene Island.** Enhance Atchafalaya River influence in eastern Atchafalaya Bay, Point Au Fer Island, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene Island. This 22,700-foot barrier would separate Atchafalaya Bay from the gulf and would follow the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the effects of gulf waves and the erosive effects of strong frontal passages. It would benefit Point au Fer Island wetlands and Fourleague Bay wetlands by increasing Atchafalaya River influence while reducing gulf influence.
- **Rebuild Historic Reefs - Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh ISLAND to the west**. Enhance Atchafalaya Delta growth and Atchafalaya River influence in Sub Province 3 by constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west. The 107,700-foot barrier would join the Bayou Sale natural levee feature. This feature would reduce delta wetland erosion caused by gulf wave action and would increase containment of Atchafalaya sediments in Atchafalaya Bay.
- **Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands.** This proposal would alter the ORCS operational framework with a goal of increasing the sediment load to be transported by the Atchafalaya River. An approximate 20 percent increase in delta growth was proposed as the feature objective but would be refined upon detailed evaluation of the feature. Detailed studies of this proposal would include determination of impacts (beneficial and adverse) to the interior of the Atchafalaya Basin, the degree to which flow and sediment distributions would be required, and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red and Atchafalaya Rivers.
- **Multi-purpose operation of the Houma Navigation Canal (HNC) Lock.** Multi-purpose operation of the Houma Navigation Canal Lock and related Morganza to the Gulf Hurricane Protection Project features. Improve the distribution of Atchafalaya flows through the HNC to the west in Falgout Canal, to the marshes east and west of the HNC, to the marshes south of the Lake Boudreaux Basin, and to the Grand Bayou marshes east of Bayou Point Au Chien. Structures would be operated during periods of low freshwater flows to reduce intrusion of high salinity water into low salinity wetlands.
- **Maintain land bridge between Bayous Dularge and Grand Caillou.** Construct a land bridge between Bayous DuLarge and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining waterbodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous 300-foot-wide and 21,000-foot-long berm of "high marsh" extending from Bayou Grand Caillou to Bayou DuLarge (leaving Bayou Sauveur open). This berm would separate the higher healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the

deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.

Subprovince 3 - Alternative R2 (Land building by delta development) – plate 21

Subprovince 3 - Alternative R2 (Land building by delta development)
1. Bayou Lafourche 1,000 cfs pump
2. Third Delta (120,000 cfs diversion)
3. Relocate the Atchafalaya navigation channel
4. Increase sediment transport down Wax Lake Outlet
5. Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
6. Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
7. Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit Coastal Wetlands
8. Freshwater introduction via Blue Hammock Bayou
9. Freshwater introduction south of Lake Decade
10. Penchant Basin Plan
11. Multi-purpose operation of the Houma Navigation Canal Lock (HNC)

- **Bayou Lafourche 1,000 cfs pump.** A flow of 1,000 CFS would be pumped into Bayou Lafourche. The scale wetland benefit area is the area between Bayous Lafourche and Terrebonne, south of the GIWW. The flow would be continuous and would freshen the wetlands and would reduce loss rates.
- **Third Delta (120,000 cfs diversion).** Build land in upper Timbalier Subbasin with a Mississippi River diversion (Third Delta). The Third Delta conveyance channel would parallel the east side of the Bayou Lafourche natural levee and split into 2 distributary channels. One would distribute flow and sediment to the Little Lake area of the Pointe au Chien area of the Timbalier Subbasin. The conveyance channel would be sized to have land building capability similar to the Wax Lake Outlet. (120,000 cfs with sediment enrichment)
- **Relocate the Atchafalaya navigation channel.** This feature consists of relocating the Atchafalaya navigation channel. The Navigation Channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the Channel and using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the delta lobes.
- **Increase sediment transport down Wax Lake Outlet.** Increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet (WLO) flows pass over the relatively shallow Six Mile Lake before entering the outlet. This feature would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby

increasing more bed load sediments to be transported to the WLO delta. Increased delta growth was projected by the LSU CELSS Western Bays Model.

- **Rebuild Historic Reefs - Rebuild historic barrier between Point Au Fer and Eugene Island.** Enhance Atchafalaya River influence in eastern Atchafalaya Bay, Point Au Fer ISLAND, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene ISLAND. This 22,700-foot barrier would separate Atchafalaya Bay from the gulf and would follow the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the effects of gulf waves and the erosive effects of strong frontal passages. It would benefit Point au Fer Island wetlands and Fourleague Bay wetlands by increasing Atchafalaya River influence while reducing gulf influence.
- **Rebuild Historic Reefs - Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh ISLAND to the west**. Enhance Atchafalaya Delta growth and Atchafalaya River influence in Sub Province 3 by constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west. The 107,700-foot barrier would join the Bayou Sale natural levee feature. This feature would reduce delta wetland erosion caused by wave action of increased containment of Atchafalaya sediments in Atchafalaya Bayou.
- **Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands.** This proposal would alter the ORCS operational framework with a goal of increasing the sediment load to be transported by the Atchafalaya River. An approximate 20 percent increase in delta growth was proposed as the feature objective but would be refined upon detailed evaluation of the feature. Detailed studies of this proposal would include determination of impacts (beneficial and adverse) to the interior of the Atchafalaya Basin, the degree to which flow and sediment distributions would be required, and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red and Atchafalaya Rivers.
- **Freshwater introduction via Blue Hammock Bayou.** This feature provides for Increasing Atchafalaya Flow to SW Terrebonne via Blue Hammock Bayou. The project would increase the distribution of Atchafalaya flows in Fourleague Bay to Lake Merchant wetlands by increasing the cross-section of Blue Hammock Bayou. Marsh would be created with material dredged. Grand Pass and Buckskin Bayou, the outlets of Lake Merchant, would be reduced in cross section to increase the retention of Atchafalaya nutrients, sediment, and freshwater.
- **Freshwater introduction south of Lake Decade.** Enhance Atchafalaya flows to Terrebonne by constructing three small conveyance channels along the south shore of Lake Decade to the Small Bayou LaPointe area. Construct three conveyance channels along the south shore of Lake Decade to deliver Atchafalaya flows to wetlands between the lake, Bayou Dularge, and Lake Merchant. Channel flows would be controlled by structures that could be actively operated. Intermediate marsh losses would be reduced by lowering salinities and increasing nutrient inputs.
- **Penchant Basin Plan.** Reduce excessive water levels in the upper Penchant Subbasin by implementing the Penchant Basin Plan. The Penchant Basin Plan would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya

River stages fall after spring floods. Increased outlet capacities would utilize the flows to increase the circulation and retention to wetlands in the more tidal zone below the large fresh floating marsh zone. Wetlands losses would be reduced in both zones (LSU CELSS model results).

- **Multi-purpose operation of the Houma Navigation Canal (HNC) Lock.** This feature provides for the multi-purpose operation of the Houma Navigation Canal Lock and related Morganza to the Gulf Hurricane Protection Project features. Improve the distribution of Atchafalaya flows through the HNC to the west in Falgout Canal, to the marshes east and west of the HNC, to the marshes south of the Lake Boudreaux Basin, and to the Grand Bayou marshes east of Bayou Point Au Chien. Structures would be operated during periods of low freshwater flows to reduce intrusion of high salinity water into low salinity wetlands.

Subprovince 3 - Alternative R3 (Mississippi and Atchafalaya Flows) – plate 22

Subprovince 3 - Alternative R3 (Mississippi and Atchafalaya Flows)
1. Stabilize banks of Southwest Pass
2. Maintain northern shore of East Cote Blanche Bay at P Marone
3. Rebuild Point Chevreuil Reef
4. Rehabilitate Terrebonne Barrier Islands
5. Rehabilitate northern shorelines of Terrebonne/Timbalier Bays
6. Backfill pipeline canals
7. Multi-purpose operation of the Houma Navigation Canal Lock
8. Maintain land bridge between Bayous Dularge and Grand Caillou
9. Maintain land bridge between Caillou Lake and the gulf
10. Stabilize gulf shoreline of Pt. Au Fer Island
11. Maintain Timbalier land bridge
12. Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
13. Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
14. Convey Atchafalaya River water to Terrebonne marshes
15. Penchant Basin Plan

Maximum rehabilitation/maintenance of geomorphic features

- **Stabilize banks of Southwest Pass.** Maintain Southwest Pass integrity by protecting bay and gulf Shorelines. Southwest Pass banks are eroding and may result in greater exchange between Vermilion Bay and the gulf. The pass banks would be stabilized with armor to maintain the existing pass dimensions. This would involve the construction of 9.33 miles of dike at a width of 200 feet.
- **Maintain northern shore of East Cote Blanche Bay at P. Marone.** Protect North shore of East Cote Blanche Bay from Point Marone to Jackson Bayou. Approximately 23,600 feet of bay shoreline would be stabilized to protect the interior wetland water circulation patterns in the Cote Blanche Wetlands CWPPRA project. The project was

designed to increase the retention time of the Atchafalaya flows moving from the GIWW to East Cote Blanche Bay. Shoreline erosion is thought to have increased with dredging of shell reefs between the bay and gulf.

- **Rebuild Point Chevreuil Reef.** This feature provides for rebuilding historic Point Chevreuil Reef toward Marsh Island. Rehabilitate the Bayou Sale natural levee between Point Chervil and the gulf. The natural levee would be rebuilt in the form of a shallow sub aqueous platform, small islands, and/or reefs. The historic shell reefs were removed by shell dredging. The feature would be about 12 miles long and would deflect some of Atchafalaya flow and sediments from entering East Cote Blanche Bay resulting in slightly higher salinities in the bay. Overall, this feature would restore some semblance of historic hydrologic conditions in the Teche/Vermilion Basin.
- **Rehabilitate Terrebonne barrier islands.** This feature provides for the restoration of the Timbalier and Derrieres barrier island chains (Alternative a). This would simulate the 1890 condition with fewer breaches than now. The islands would be widened to 600m and the dune crest elevation would be 2.7 m (NGVD).
- **Rehabilitate northern shorelines of Terrebonne/Timbalier Bays.** This feature provides for the rehabilitation of the northern shorelines of Terrebonne/Timbalier Bays with a segmented breakwater from the Seabreeze area to the Little Lake area. Rebuild and maintain the historic shoreline integrity around Terrebonne and Timbalier Bays by constructing 338,000 feet of segmented barrier along the west side of Terrebonne Bay, across the historic shoreline alignment along the northern sides of both bays, and along the east of Timbalier Bay. This feature was simulated by a wave model in DNR-funded Barrier Shoreline Feasibility Study conducted by T. Baker Smith (1999). The model results showed substantial benefits in reducing wetlands loss along the shoreline.
- **Backfill pipeline canals.** This feature provides for the backfill of pipeline canals S. of Catfish Lake. The Twin Pipeline canals in this area are crossed by numerous oilfield canals greatly altering natural water circulation patterns. The 63,300 feet of pipeline canals would be filled at strategic locations to restore primary water circulation through Grand Bayou Blue. The retention time of Atchafalaya and Bayou Lafourche (pumped) flows would be increased to benefit effected wetlands.
- **Multi-purpose operation of the Houma Navigation Canal Lock.** This feature provides for the multi-purpose operation of the Houma Navigation Canal Lock and related Morganza to the Gulf Hurricane Protection Project features. Improve the distribution of Atchafalaya flows through the HNC to the west in Falgout Canal, to the marshes east and west of the HNC, to the marshes south of the Lake Boudreaux Basin, and to the Grand Bayou marshes east of Bayou Point Au Chien. Structures would be operated during periods of low freshwater flows to reduce intrusion of high salinity water into low salinity wetlands.
- **Maintain land bridge between Bayous Dularge and Grand Caillou.** This feature provides for construction of a land bridge between Bayous DuLarge and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining waterbodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous 300-foot-wide and 21,000-foot-long berm of "high marsh" extending from Bayou Grand Caillou to Bayou DuLarge (leaving Bayou Sauveur open). This berm

would separate the higher healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.

- **Maintain land bridge between Caillou Lake and the gulf.** Maintain the land bridge between the gulf and Caillou Lake by shore protection in Grand Bayou DuLarge to minimize salinity intrusion. This project would involve 43,000 feet of rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou DuLarge, where a new channel is threatening to breach the bayou bank and allow the establishment of a new connection with Caillou Lake. Some gulf shore armoring would likely be needed to protect these features from erosion on the gulf shoreline. A more systemic and comprehensive solution would involve a much greater amount of gulf shoreline armoring, especially toward the west where shoreline retreat and loss of shoreline oyster reefs has allowed for increased water exchange between the gulf and the interior waterbodies (between Bay Junop and Caillou Lake). Some of the newly opened channels would be closed to restore historic cross-sections of exchange points. By reducing marine influences in these interior areas, these features might also allow increased riverine influences from Four League Bay to benefit area marshes.
- **Stabilize gulf shoreline of Point Au Fer Island.** This feature provides for stabilizing the gulf shoreline of Point Au Fer Island. Stabilize 81,500 feet of the gulf shoreline of Point Au Fer I to prevent direct connections between the gulf and interior water bodies. The gulf shoreline erosion would be arrested along the island thereby reducing the direct losses from the erosion. Indirectly, island marsh loss would be reduced by preventing the interior water circulation avenues from being connected directly to the gulf rather than Atchafalaya Bay and Fourleague Bay. The fresh nutrient and sediment rich bay waters provide for wetland needs much better than the high salinity gulf waters.
- **Maintain Timbalier land bridge.** This feature provides for maintaining the Timbalier land bridge in the upper salt marsh zone. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining waterbodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous 2,000-foot-wide and 111,000-foot-long berm of "high marsh" extending from Bayou Terrebonne to Bayou Lafourche (leaving several Bayous open). This berm would allow the freshwater flowing down from the GIWW through Grand Bayou to have a greater influence on interior marshes through existing water exchange points along Grand Bayou north of the proposed land bridge.
- **Rebuild historic reef - Rebuild historic barrier between Point Au Fer and Eugene Island.** Enhance Atchafalaya River influence in eastern Atchafalaya Bay, Pt Au Fer Island, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene Island. This 22,700-foot barrier would separate Atchafalaya Bay from the gulf and would follow the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the effects of gulf waves and the erosive effects of strong frontal passages. It would benefit Point au Fer Island wetlands and Fourleague Bay wetlands by increasing Atchafalaya River influence while reducing gulf influence.

- **Rebuild historic reef - Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh ISLAND to the west.** Enhance Atchafalaya Delta growth and Atchafalaya River influence in Sub Province 3 by constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west. The 107,700-foot barrier would join the Bayou Sale natural levee feature. This feature would reduce delta wetland erosion caused by wave action of increased containment of Atchafalaya sediments in Atchafalaya Bayou.
- **Convey Atchafalaya River water to Terrebonne marshes.** This feature provides for enhancing existing Atchafalaya River influence to central (Lake Boudreaux) and eastern (Grand Bayou) Terrebonne marshes via GIWW. During peak Atchafalaya River stages, over 10,000 cfs of water flows into Houma via the GIWW. Most (70 percent) of this flows southward through the HNC to the bays. The remainder flows eastward through the GIWW, past Larose, into the Barataria Basin. This project would introduce flow into the Grand Bayou basin by enlarging the connecting channel (Bayou L'Eau Bleu) so to capture as much of the surplus flow (max. 2000-4000 cfs) that is otherwise leaves the Terrebonne Basin. Initial alternatives to be evaluated through hydrologic models include enlargement to a uniform 1,200 and 2,000 sq. feet through the entire length of the Bayou L'Eau Bleu/Grand Bayou Canal channels. Another scale area to be evaluated is the enlargement of the St. Louis Canal to 600 sq. feet from the GIWW southward to Bayou Pointe au Chien (presently its roughly 100 -150 sq. feet at narrowest sections). In all cases, gated control structures would be installed to restrict channel cross-section during the salty season to prevent increased saltwater intrusion. Some alternatives may include auxiliary freshwater distribution structures to improve the distribution of introduced freshwater. For the Lake Boudreaux Basin scale area, introduction would be evaluated via Bayou Pelton (1,500 sq. foot cross section) and at Company Canal (1,000 sq. foot cross-section). When fully implemented, this project might involve construction of one alternative at Bayou L'Eau Bleu, St. Louis Canal, Bayou Pelton, and Company Canal.
- **Penchant Basin Plan.** Reduce excessive water levels in the upper Penchant Subbasin by implementing the Penchant Basin Plan. The Penchant Basin Plan would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods. Increased outlet capacities would utilize the flows to increase the circulation and retention to wetlands in the more tidal zone below the large fresh floating marsh zone. Wetlands losses would be reduced in both zones (LSU CELSS model results).

<u>Subprovince 3 - Maintain (cut loss by 2,842 ac/yr.)</u>

<u>Subprovince 3 - Alternative M1 (All features) – plate 23</u>

Subprovince 3 – Alternative M1 (Use all features)
1. Third Delta (120,000 cfs diversion)
2. Bayou Lafourche 1,000 cfs pump
3. Relocate the Atchafalaya navigation channel
4. Increase sediment transport down Wax Lake Outlet
5. Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
6. Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
7. Study the modification of the Old River Control Structure (ORCS) Operational Scheme to Benefit Coastal Wetlands
8. Convey Atchafalaya River water to Terrebonne marshes
9. Freshwater introduction via Blue Hammock Bayou
10. Freshwater introduction south of Lake Decade
11. Penchant Basin Plan
12. Stabilize banks of Southwest Pass
13. Maintain northern shore of East Cote Blanche Bay at Pt. Marone
14. Rebuild Point Chevreuil Reef
15. Rehabilitate Terrebonne Barrier Islands
16. Rehabilitate northern shorelines of Terrebonne/Timbalier Bays
17. Backfill pipeline canals
18. Multi-purpose operation of the Houma Navigation Canal Lock
19. Maintain land bridge between Bayous Dularge and Grand Caillou
20. Maintain land bridge between Caillou Lake and the gulf
21. Stabilize gulf shoreline of Point Au Fer Island
22. Maintain Timbalier land bridge

- **Third Delta (120,000 cfs diversion).** Build land in upper Timbalier Subbasin with a Mississippi River diversion (Third Delta). The Third Delta conveyance channel would parallel the east side of the Bayou Lafourche natural levee and split into two distributary channels. One would distribute flow and sediment to the Little Lake area of the Pointe au Chien area of the Timbalier Subbasin. The conveyance channel would be sized to have land building capability similar to the Wax Lake Outlet. (120,000 cfs with sediment enrichment)

- **Bayou Lafourche 1,000 cfs pump.** A flow of 1000 CFS would be pumped into Bayou Lafourche. The scale wetland benefit area is the area between Bayous Lafourche and Terrebonne, south of the GIWW. The flow would be continuous and would freshen the wetlands and would reduce loss rates.
- **Relocate the Atchafalaya navigation channel.** This feature consists of relocating the Atchafalaya navigation channel. The Navigation Channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the Channel and using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the delta lobes.
- **Increase sediment transport down Wax Lake Outlet.** Increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet (WLO) flows pass over the relatively shallow Six Mile Lake before entering the outlet. This feature would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby increasing more bed load sediments to be transported to the WLO delta. Increased delta growth was projected by the LSU CELSS Western Bays Model.
- **Rebuild Historic Reefs - Rebuild historic barrier between Point Au Fer and Eugene Island.** Enhance Atchafalaya River influence in eastern Atchafalaya Bay, Pt Au Fer Island, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene Island This 22,700-foot barrier would separate Atchafalaya Bay from the gulf and would follow the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the effects of gulf waves and the erosive effects of strong frontal passages. It would benefit Point au Fer I wetlands and Fourleague Bay wetlands by increasing Atchafalaya River influence while reducing gulf influence.
- **Rebuild Historic Reefs - Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west**. Enhance Atchafalaya Delta growth and Atchafalaya River influence in Sub Province 3 by constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh I to the west. The 107,700-foot barrier would join the Bayou Sale natural levee feature. This feature would reduce delta wetland erosion caused by wave action of increased containment of Atchafalaya sediments in Atchafalaya Bayou.
- **Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands.** This proposal would alter the ORCS operational framework with a goal of increasing the sediment load to be transported by the Atchafalaya River. An approximate 20 percent increase in delta growth was proposed as the feature objective but would be refined upon detailed evaluation of the feature. Detailed studies of this proposal would include determination of impacts (beneficial and adverse) to the interior of the Atchafalaya Basin, the degree to which flow and sediment distributions would be required, and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red and Atchafalaya Rivers.
- **Convey Atchafalaya River water to Terrebonne marshes.** This feature provides for increasing Atchafalaya River flows to Terrebonne Basin by a diversion in the Avoca Island Levee, repairing eroding banks of the GIWW, and enlarging constrictions in the

GIWW below Gibson and in Houma. Ideally, half of Bayou Shaffer flow, or more, would be diverted (via an open unstructured cut through the levee) into Avoca Lake to maximize land building. The percent flow diverted would be reduced if high water level impacts in the Penchant marshes would be too great. A constriction structure in Bayou Shaffer would be installed downstream of the levee cut to force flow into Avoca Lake. Several new channels connecting the eastern portions of Avoca Lake with Bayou Chene would be constructed to facilitate the distribution of sediments (land-building) across a wider portion of the lake bottom. Introduced flows leaving Avoca Lake would be readily carried southward down Bayou Penchant, increasing its sediment load, compared to the existing conditions where water has to back-up to Bayou Penchant through the Avoca Island Cutoff Channel. In lieu of a diversion from Bayou Shaffer into Avoca Lake, an alternative might be to partially or fully breach the Avoca Island Extension Levee where Bayou Shaffer runs adjacent to the Avoca Island Cutoff Canal. This cut would also involve an open armored channel.

In conjunction with the Bayou Shaffer diversion, sections of eroded dredged material banks along the GIWW would be repaired to contain flows for more efficient delivery to areas of need further east and to halt boat wake-induced erosion of shoreline marshes.

In conjunction with the above features, and to better carry water eastward to brackish areas of need, the GIWW constrictions would be enlarged. In Bayou Chene, the channel is roughly 12,000 sq. feet. But between Bayou Black and Bay Wallace, the channel is reduced to 5,500 sq. feet. The most severe constriction is in Houma where cross-section is reduced to as little as 2,200 sq. feet at the Bayou Terrebonne junction. An initial concept is to construct and maintain an 8,000 sq. foot channel through Houma. This concept is very closely linked with project number 5a above and would be considered only if that project shows that the presently available freshwater can be fully utilized through features to introduce it into needy marshes south of the GIWW. This project would involve dredging to enlarge channel cross-section and relocations of businesses and utilities, together with bridge modifications as needed. The Houma GIWW tunnel may limit the degree to which the channel can be enlarged at the tunnel location.

- **Freshwater introduction via Blue Hammock Bayou.** This feature provides for Increasing Atchafalaya Flow to SW Terrebonne via Blue Hammock Bayou. The project would increase the distribution of Atchafalaya flows in Fourleague Bay to Lake Merchant wetlands by increasing the cross-section of Blue Hammock Bayou. Marsh would be created with material dredged. Grand Pass and Buckskin Bayou, the outlets of Lake Merchant, would be reduced in cross section to increase the retention of Atchafalaya nutrients, sediment, and freshwater.
- **Freshwater introduction south of Lake Decade.** Enhance Atchafalaya flows to Terrebonne by constructing three small conveyance channels along the south shore of Lake Decade to the Small Bayou LaPointe area. Construct 3 conveyance channels along the south shore of Lake Decade to deliver Atchafalaya flows to wetlands between the lake, Bayou Dularge, and Lake Merchant. Channel flows would be controlled by structures that could be actively operated. Intermediate marsh losses would be reduced by lowering salinities and increasing nutrient inputs.

- **Penchant Basin Plan.** Reduce excessive water levels in the upper Penchant Subbasin by implementing the Penchant Basin Plan. The Penchant Basin Plan would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods. Increased outlet capacities would utilize the flows to increase the circulation and retention to wetlands in the more tidal zone below the large fresh floating marsh zone. Wetlands losses would be reduced in both zones (LSU CELSS model results).
- **Stabilize banks of Southwest Pass.** Maintain Southwest Pass integrity by protecting bay and gulf Shorelines. Southwest Pass banks are eroding and may result in greater exchange between Vermilion Bay and the gulf. The pass banks would be stabilized with armor to maintain the existing pass dimensions. This would involve the construction of 9.33 miles of dike at a width of 200 feet.
- **Maintain northern shore of East Cote Blanche Bay at Point Marone.** Protect North shore of East Cote Blanche Bay from Point Marone to Jackson Bayou. Approximately 23,600 feet of bay shoreline would be stabilized to protect the interior wetland water circulation patterns in the Cote Blanche Wetlands CWPPRA project. The project was designed to increase the retention time of the Atchafalaya flows moving from the GIWW to East Cote Blanche Bay. Shoreline erosion is thought to have increased with dredging of shell reefs between the bay and gulf.
- **Rebuild Point Chevreuil Reef.** This feature provides for rebuilding historic Point Chevreuil Reef toward Marsh Island. Rehabilitate the Bayou Sale natural levee between Point Chervil and the gulf. The natural levee would be rebuilt in the form of a shallow sub aqueous platform, small islands, and/or reefs. The historic shell reefs were removed by shell dredging. The feature would be about 12 miles long and would deflect some of Atchafalaya flow and sediments from entering East Cote Blanche Bay resulting in slightly higher salinities in the bay. Overall, this feature would restore some semblance of historic hydrologic conditions in the Teche/Vermilion Basin.
- **Rehabilitate Terrebonne barrier islands.** This feature provides for the restoration of the Timbalier and Derrieres barrier island chains (Alternative a). This would simulate the 1890 condition with fewer breaches than now. The islands would be widened to 600m and the dune crest elevation would be 2.7 m (NGVD).
- **Rehabilitate northern shorelines of Terrebonne/Timbalier Bays.** This feature provides for the rehabilitation of the northern shorelines of Terrebonne/Timbalier Bays with a segmented breakwater from the Seabreeze area to the Little Lake area. Rebuild and maintain the historic shoreline integrity around Terrebonne and Timbalier Bays by constructing 338,000 feet of segmented barrier along the west side of Terrebonne Bay, across the historic shoreline alignment along the northern sides of both bays, and along the east of Timbalier Bay. This feature was simulated by a wave model in DNR-funded Barrier Shoreline Feasibility Study conducted by T. Baker Smith (1999). The model results showed substantial benefits in reducing wetlands loss along the shoreline.
- **Backfill pipeline canals.** This feature provides for the backfill of pipeline canals S. of Catfish Lake. The Twin Pipeline canals in this area are crossed by numerous oilfield canals greatly altering natural water circulation patterns. The 63,300 feet of pipeline canals would be filled at strategic locations to restore primary water circulation through Grand Bayou Blue. The retention time of Atchafalaya and Bayou Lafourche (pumped) flows would be increased to benefit effected wetlands.

- **Multi-purpose operation of the Houma Navigation Canal Lock.** This feature provides for the multi-purpose operation of the Houma Navigation Canal Lock and related Morganza to the Gulf Hurricane Protection Project features. Improve the distribution of Atchafalaya flows through the HNC to the west in Falgout Canal, to the marshes east and west of the HNC, to the marshes south of the Lake Boudreaux Basin, and to the Grand Bayou marshes east of Bayou Point Au Chien. Structures would be operated during periods of low freshwater flows to reduce intrusion of high salinity water into low salinity wetlands.
- **Maintain land bridge between Bayous Dularge and Grand Caillou.** This feature provides for construction of a land bridge between Bayous DuLarge and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining waterbodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous 300-foot-wide and 21,000-foot-long berm of "high marsh" extending from Bayou Grand Caillou to Bayou DuLarge (leaving Bayou Sauveur open). This berm would separate the higher healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.
- **Maintain land bridge between Caillou Lake and the gulf.** Maintain the land bridge between the gulf and Caillou Lake by shore protection in Grand Bayou DuLarge to minimize salinity intrusion. This project would involve 43,000 feet of rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou DuLarge, where a new channel is threatening to breach the bayou bank and allow the establishment of a new connection with Caillou Lake. Some gulf shore armoring would likely be needed to protect these features from erosion on the gulf shoreline. A more systemic and comprehensive solution would involve a much greater amount of gulf shoreline armoring, especially toward the west where shoreline retreat and loss of shoreline oyster reefs has allowed for increased water exchange between the gulf and the interior waterbodies (between Bay Junop and Caillou Lake). Some of the newly opened channels would be closed to restore historic cross-sections of exchange points. By reducing marine influences in these interior areas, these features might also allow increased riverine influences from Four League Bay to benefit area marshes.
- **Stabilize gulf shoreline.** This feature provides for stabilizing the gulf shoreline of Point Au Fer Island. Stabilize 81,500 feet of the gulf shoreline of Point Au Fer I to prevent direct connections between the gulf and interior water bodies. The gulf shoreline erosion would be arrested along the island thereby reducing the direct losses from the erosion. Indirectly, island marsh loss would be reduced by preventing the interior water circulation avenues from being connected directly to the gulf rather than Atchafalaya Bay and Fourleague Bay. The fresh nutrient and sediment rich bay waters provide for wetland needs much better than the high salinity gulf waters.
- **Maintain Timbalier land bridge.** This feature provides for maintaining the Timbalier land bridge in the upper salt marsh zone. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and

adjoining waterbodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous 2,000-foot-wide and 111,000-foot-long berm of "high marsh" extending from Bayou Terrebonne to Bayou Lafourche (leaving several Bayous open). This berm would allow the freshwater flowing down from the GIWW through Grand Bayou to have a greater influence on interior marshes through existing water exchange points along Grand Bayou north of the proposed land bridge.

SUBPROVINCE 4 – CHENIER PLAIN

This section would address alternatives for Subprovince 4 with the following scales: (1) maintain and (2) increase. There is a total of ten alternatives for this subprovince: three "maintain" (M); three "increase" (E); and No Action (N).

Subprovince 4				**M1**	**M2**	**M3**	**E1**	**E2**	**E3**	**N1**
Black Bayou Bypass culverts.										x
Calcasieu Pass Lock				x			x			
Calcasieu Ship Channel Beneficial Use				x	x	x	x	x	x	x
Chenier Plain Freshwater Management and Allocation Reassessment.										x
Dedicated Dredging for Marsh Restoration					x	x		x	x	
East Sabine Hydrologic Restoration					x			x		x
Freshwater introduction at Highway 82				x	x	x	x	x	x	x
Freshwater introduction at Little Pecan Bayou				x	x	x	x	x	x	x
Freshwater introduction at Pecan Island				x	x	x	x	x	x	x
Freshwater introduction at Rollover Bayou				x	x	x	x	x	x	x
Freshwater introduction at South Grand Chenier				x	x	x	x	x	x	x
Freshwater introduction via Calcasieu Lock and Black Bayou culverts						x			x	
Gulf Shoreline Stabilization					x		x	x	x	x
Modify existing Cameron-Creole Watershed Control Structures					x			x		x
New Lock at the GIWW					x			x		
Sabine Pass Lock				x			x			
Salinity control at Alkali Ditch					x			x		x
Salinity control at Black Bayou					x			x		x
Salinity control at Black Lake Bayou					x			x		x
Salinity control at Highway 82 Causeway					x	x		x	x	x
Salinity control at Long Point Bayou.					x			x		x
Salinity control at Oyster Bayou					x			x		x

Note: Gross rates of restored/ protected wetlands: M = Maintain, 461 ac/yr ; E = Enhance, 692 ac/yr;
Scales: 1 = Large-scale salinity control; 2 = Perimeter salinity control; 3 = Freshwater introduction salinity control. Column N1 represents the Supplemental Framework.

Subprovince 4 – Maintain [Marsh Gain; 461 ac/yr, Marsh Gain Equals/Exceeds - 461 ac/yr Loss Rate]

Subprovince 4 - Alternative M1 (Large Scale Salinity Control) – plate 24

Subprovince 4 - Alternative M1 (Large Scale Salinity Control)
1. Sabine Pass Lock
2. Calcasieu Pass Lock
3. Freshwater introduction at Pecan Island
4. Freshwater introduction at Rollover Bayou
5. Freshwater introduction at Highway 82
6. Freshwater introduction at Little Pecan Bayou
7. Freshwater introduction at South Grand Chenier
8. Calcasieu Ship Channel Beneficial Use

- **Sabine Pass Lock.** Gate/Lock on Sabine Pass south of Lighthouse Bayou near gulf ; 42 feet deep X 500 feet or > wide with a medium boat bay (crew and shrimp boats); (Boat bay - 100 feet wide X 12 feet deep).
- **Calcasieu Pass Lock.** Lock in Pass, Lock & natural pass open, Lock & natural pass constricted. Gate or lock in the Calcasieu Ship Channel with a small to medium boat bay (100 feet wide X 12 feet deep) or bypass through historic natural river pass. Located in the vicinity of Monkey Island.
- **Freshwater Introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at Pecan Island.
- **Freshwater Introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at Rollover Bayou.
- **Freshwater Introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal into eastern Rockefeller Refuge.
- **Freshwater Introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater Introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin to the Hog Bayou Watershed.
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.

<u>Subprovince 4 - Alternative M2 (Perimeter Salinity Control) – plate 25</u>

Subprovince 4 - Alternative M2 (Perimeter Salinity Control)
1. Salinity control at Oyster Bayou
2. Salinity control at Long Point Bayou
3. Salinity control at Black Lake Bayou
4. Salinity control at Alkali Ditch
5. New Lock at the GIWW
6. Modify existing Cameron-Creole Watershed Control Structures
7. East Sabine Lake Hydrologic Restoration
8. Salinity control at Black Bayou
9. Salinity control at Highway 82 Causeway
10. Freshwater introduction at Pecan Island
11. Freshwater introduction at Rollover Bayou
12. Freshwater introduction at Highway 82
13. Freshwater introduction at Little Pecan Bayou
14. Freshwater introduction at South Grand Chenier
15. Calcasieu Ship Channel Beneficial Use
16. Dedicated Dredging for Marsh Restoration
17. Gulf Shoreline Stabilization

- **Calcasieu Subbasin Perimeter Framework**
  - **Salinity control at Oyster Bayou**. Salinity control in Oyster Bayou with a gated structure or rock weir. Location in Oyster Bayou about 1 mile west of Calcasieu Ship Channel 100-150 feet wide X 10 feet deep; with an approximately 15-20 foot wide X 4 foot deep boat bay.
  - **Salinity control at Long Point Bayou**. Salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27 west of the Calcasieu Ship Channel (Existing dimensions equal 40 feet wide X 5 feet deep; structure approximate dimensions are 10 to 15 feet wide X 4 feet deep boat bay).
  - **Salinity control at Black Lake Bayou.** - Salinity control in Black Lake Bayou with gated structure or rock weir with boat bay. Location in Black Lake Bayou north of Hackberry near Calcasieu Ship Channel (Existing bayou dimensions are approximately 150 feet wide X10 feet deep; gated structure or rock weir approximate dimensions equal 25 to 50 feet wide X 6 to 8 feet deep boat bay).
  - **Salinity control at Alkali Ditch**. - Salinity control at the Alkali Ditch, northwest of Hackberry, LA at the GIWW, with gated structure or rock weir with barge bay (Existing dimensions are approximately 150 to 200 feet wide X 8 to10 feet deep; structure or weir with approximate dimensions 70 feet wide X 8 feet deep).
  - **New Lock at the GIWW**. - New Lock at the GIWW east of Alkali Ditch dimensions - 75 -110 feet wide X 15 feet deep.
  - **Modify existing Cameron-Creole Watershed Control Structures**. The Cameron-Creole watershed project constructed in 1989 consists of 5 large concrete water control structures and a 16 mile-long levee along the shoreline of

Calcasieu Lake. Three of the five structures (Grand Bayou, Bois Connine Bayou, and Lambert Bayou) are adjustable structure with slide gates and the remaining two (Mangrove Bayou and No Name Bayou) are fixed crest weir structures. The fixed crest weir sill heights may be set too high. This higher setting could be contributing to the impoundment problem within Cameron-Creole marshes adjacent to those structures. If the weir sills for these two structures could be modified to lower weir crests reduced impoundment, greater water flow, and increased fisheries access independent of salinity control at Calcasieu Pass.

- **Sabine Subbasin Perimeter Framework**
    - **East Sabine Lake Hydrologic Restoration**. East Sabine Lake Hydrologic Restoration Project between Sabine Lake and Sabine NWR Pool 3; salinity control structures at Willow Bayou, Three Bayou, Greens Bayou and Right Prong of Black Bayou, terracing, Sabine Lake shoreline protection, & smaller structures.
    - **Salinity control at Black Bayou**. Salinity control structure with boat bay at mouth of Black Bayou (either gated structure or a rock weir), located at the intersection of Black Bayou and the northeastern shoreline of Sabine Lake (Existing bayou dimensions are 150 to 200 feet wide X 10 feet deep).
    - **Salinity control at Highway 82 Causeway**. This feature provides rock weir at Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass and the Sabine-Neches Waterway Existing dimensions equal approximately 3,400 feet wide by approximately 4 feet deep except at the approximate 10 feet deep center channel.

- **Freshwater Introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge.
- **Freshwater Introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater Introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou Watershed.
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.
- **Dedicated Dredging for Marsh Restoration**. Use Dredged Material Beneficially to restore 5,000 acres or more on Sabine NWR and adjacent properties. Locations for marsh restoration would be north and NW of Browns Lake on Sabine NWR. Average water depths equal 1.5 to 2 feet deep.

- **Gulf Shoreline Stabilization**. This feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou. Gulf Shoreline Stabilization using rock foreshore dikes, offshore reefs, or segmented breakwaters. Located from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Foreshore dikes 25 to 50 feet gulfward of shore in shallow water 1 to 3 feet deep with gaps every 1,000 feet. Subaqueous rock reef placed 150 to 100 feet gulfward from shore in 2 to 5 feet depth of water. Segmented breakwaters designed similar to Holly Beach Breakwaters placed closer to shore (100 feet or closer) and with narrower gaps (approximately 250 feet long with 50 feet gaps).

<u>Subprovince 4 - Alternative M3 (Freshwater Introduction Salinity Control) – plate 26</u>

Subprovince 4 - Alternative M3 (Freshwater Introduction Salinity Control)
1. Salinity control at Highway 82 Causeway
2. Freshwater introduction via Calcasieu Lock and the Black Bayou culverts
3. Freshwater introduction at Pecan Island
4. Freshwater introduction at Rollover Bayou
5. Freshwater introduction at Highway 82
6. Freshwater introduction at Little Pecan Bayou
7. Freshwater introduction at South Grand Chenier
8. Calcasieu Ship Channel Beneficial Use
9. Dedicated Dredging for Marsh Restoration

- **Salinity control at Highway 82 Causeway**. This feature provides for a Rock Weir at Hwy 82 Causeway. Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass & the Sabine-Neches Channel. Dimensions - 3,400 feet wide by about 4 feet deep except middle channel > 10 feet deep.
- **Freshwater introduction via Calcasieu Lock and the Black Bayou culverts.** This feature provides for the replacement of the Calcasieu Lock in the GIWW west of the Hwy 384 Bridge and use old lock for freshwater introduction to the upper Calcasieu estuary from the Mermentau Basin. This feature also provides for freshwater introduction via the Black Bayou Culverts feature at the intersection of Black Bayou and Hwy 384.
- **Freshwater Introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge.

- **Freshwater Introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater Introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou Watershed.
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.
- **Dedicated Dredging for Marsh Restoration**. Use Dredged Material Beneficially to restore 5,000 acres or more on Sabine NWR and adjacent properties. Locations for marsh restoration would be north and NW of Browns Lake on Sabine NWR. Average water depths equal 1.5 to 2 feet deep.

<u>Subprovince 4 – Increase [Marsh Gain; 692 ac/yr, Reduce Loss 1.5 Times Loss Rate (- 461ac/yr)]</u>

<u>Subprovince 4 - Alternative E1 (Large Scale Salinity Control) – plate 27</u>

Subprovince 4 – Alternative E1 (Large Scale Salinity Control)
1. Sabine Pass Lock
2. Calcasieu Pass Lock
3. Freshwater introduction at Pecan Island
4. Freshwater introduction at Rollover Bayou
5. Freshwater introduction at Highway 82
6. Freshwater introduction at Little Pecan Bayou
7. Freshwater introduction at South Grand Chenier
8. Gulf Shoreline Stabilization
9. Calcasieu Ship Channel Beneficial Use

- **Sabine Pass Lock.** Gate/Lock on Sabine Pass south of Lighthouse Bayou near gulf ; 42 feet deep X 500 feet or > wide with a medium boat bay (crew and shrimp boats); (Boat bay - 100 feet wide X 12 feet deep)**.**
- **Calcasieu Pass Lock.** Lock in Pass, Lock & natural pass open, Lock & natural pass constricted. Gate or lock in the Calcasieu Ship Channel with a small to medium boat bay (100 feet wide by 12 feet deep) or bypass through historic natural river pass. Located in the vicinity of Monkey Island.
- **Freshwater Introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at Pecan Island.
- **Freshwater Introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at Rollover Bayou.
- **Freshwater Introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the

Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal into eastern Rockefeller Refuge.

- **Freshwater Introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater Introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin to the Hog Bayou Watershed.
- **Gulf Shoreline Stabilization**. This feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou. Gulf Shoreline Stabilization using rock foreshore dikes, offshore reefs, or segmented breakwaters. Located from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Foreshore dikes 25 to 50 feet gulfward of shore in shallow water 1 to 3 feet deep with gaps every 1,000 feet. Subaqueous rock reef placed 150 to 100 feet gulfward from shore in 2 to 5 feet depth of water. Segmented breakwaters designed similar to Holly Beach Breakwaters placed closer to shore (100 feet or closer) and with narrower gaps (approximately 250 feet long with 50 feet gaps).
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.

Subprovince 4 - Alternative E2 (Perimeter Salinity Control) – plate 28

Subprovince 4 – Alternative E2 (Perimeter Salinity Control)
1. Salinity control at Oyster Bayou
2. Salinity control at Long Point Bayou
3. Salinity control at Black Lake Bayou
4. Salinity control at Alkali Ditch
5. New Lock at the GIWW
6. Modify existing Cameron-Creole Watershed Control Structures
7. East Sabine Lake Hydrologic Restoration
8. Salinity control at Black Bayou
9. Salinity control at Highway 82 Causeway
10. Freshwater introduction at Pecan Island
11. Freshwater introduction at Rollover Bayou
12. Freshwater introduction at Highway 82
13. Freshwater introduction at Little Pecan Bayou
14. Freshwater introduction at South Grand Chenier
15. Gulf Shoreline Stabilization
16. Calcasieu Ship Channel Beneficial Use
17. Dedicated Dredging for Marsh Restoration

- **Calcasieu Subbasin Perimeter Framework**
  - **Salinity control at Oyster Bayou**. Salinity control in Oyster Bayou with a gated structure or rock weir. Location in Oyster Bayou about 1 mile west of Calcasieu Ship Channel 100-150 feet wide X 10 feet deep; with an approximately 15-20 feet wide X 4 feet deep boat bay.

- o **Salinity control at Long Point Bayou**. Salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27 west of Calcasieu Ship Channel (Existing dimensions equal 40 feet wide X 5 feet deep; structure approximate dimensions are 10 to 15 feet wide X 4 feet deep boat bay).
- o **Salinity control at Black Lake Bayou.** - Salinity control in Black Lake Bayou with gated structure or rock weir with boat bay. Location in Black Lake Bayou north of Hackberry near Calcasieu Ship Channel (Existing bayou dimensions are approximately 150 feet wide X10 feet deep; gated structure or rock weir approximate dimensions equal 25 to 50 feet wide X 6 to 8 feet deep boat bay).
- o **Salinity control at Alkali Ditch**. - Salinity control at the Alkali Ditch, northwest of Hackberry, LA at the GIWW, with gated structure or rock weir with barge bay (Existing dimensions are approximately 150 to 200 feet wide X 8 to10 feet deep; structure or weir with approximate dimensions 70 feet wide X 8 feet deep.
- o **New Lock at the GIWW**. - New Lock at the GIWW east of Alkali Ditch dimensions - 75 -110 feet wide X 15 feet deep.
- o **Modify existing Cameron-Creole Watershed Control Structures**. The Cameron-Creole watershed project constructed in 1989 consists of 5 large concrete water control structures and a 16 mile-long levee along the shoreline of Calcasieu Lake. Three of the five structures (Grand Bayou, Bois Connine Bayou, and Lambert Bayou) are adjustable structure with slide gates and the remaining two (Mangrove Bayou and No Name Bayou) are fixed crest weir structures. The fixed crest weir sill heights may be set too high. This higher setting could be contributing to the impoundment problem within Cameron-Creole marshes adjacent to those structures. If the weir sills for these two structures could be modified to lower weir crests reduced impoundment, greater water flow and increased fisheries access independent of salinity control at Calcasieu Pass.

- **Sabine Subbasin Perimeter Framework**
  - o **East Sabine Lake Hydrologic Restoration**. East Sabine Lake Hydrologic Restoration Project between Sabine Lake and Sabine NWR Pool 3; salinity control structures at Willow Bayou, Three Bayou, Greens Bayou and Right Prong of Black Bayou, terracing, Sabine Lake shoreline protection, & smaller structures.
  - o **Salinity control at Black Bayou**. Salinity control structure with boat bay at mouth of Black Bayou (either gated structure or a rock weir), located at the intersection of Black Bayou and the northeastern shoreline of Sabine Lake (Existing bayou dimensions are 150 to 200 feet wide X 10 feet deep).
  - o **Salinity control at Highway 82 Causeway**. This feature provides rock weir at Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass and the Sabine-Neches Waterway Existing dimensions equal approximately 3,400 feet wide by approximately 4 feet deep except at the approximate 10 feet deep center channel.
- **Freshwater Introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.

- **Freshwater Introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge.
- **Freshwater Introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater Introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou Watershed.
- **Gulf Shoreline Stabilization**. This feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou. Gulf Shoreline Stabilization using rock foreshore dikes, offshore reefs, or segmented breakwaters. Located from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Foreshore dikes 25 to 50 feet gulfward of shore in shallow water 1 to 3 feet deep with gaps every 1,000 feet. Subaqueous rock reef placed 150 to 100 feet gulfward from shore in 2 to 5 feet depth of water. Segmented breakwaters designed similar to Holly Beach Breakwaters placed closer to shore (100 feet or closer) and with narrower gaps (approximately 250 feet long with 50-foot gaps).
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.
- **Dedicated Dredging for Marsh Restoration**. Use Dredged Material Beneficially to restore 5,000 acres or more on Sabine NWR and adjacent properties. Locations for marsh restoration would be north and NW of Browns Lake on Sabine NWR. Average water depths equal 1.5 to 2 feet deep.

Subprovince 4 - Alternative E3 (Freshwater Introduction Salinity Control) – plate 29

Subprovince 4 - Alternative E3 (Freshwater Introduction Salinity Control)
1. Freshwater introduction via Calcasieu Lock and Black Bayou culverts
2. Salinity control at Highway 82 Causeway
3. Freshwater introduction at Pecan Island
4. Freshwater introduction at Rollover Bayou
5. Freshwater introduction at Highway 82
6. Freshwater introduction at Little Pecan Bayou
7. Freshwater introduction at South Grand Chenier
8. Calcasieu Ship Channel Beneficial Use
9. Dedicated Dredging for Marsh Restoration
10. Gulf Shoreline Stabilization

- **Salinity control at Highway 82 Causeway**. This feature provides for a Rock Weir at Hwy 82 Causeway. Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass & the Sabine-Neches Channel. Dimensions - 3,400 feet wide by about 4 feet deep except middle channel > 10 feet deep.
- **Freshwater introduction via Calcasieu Lock and the Black Bayou culverts.** This feature provides for the replacement of the Calcasieu Lock in the GIWW west of the Hwy 384 Bridge and use old lock for freshwater introduction to the upper Calcasieu estuary from the Mermentau Basin. This feature also provides for freshwater introduction via the Black Bayou Culverts feature at the intersection of Black Bayou and Hwy 384.
- **Freshwater Introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater Introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge.
- **Freshwater Introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater Introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou Watershed.
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.
- **Dedicated Dredging for Marsh Restoration**. Use Dredged Material Beneficially to restore 5,000 acres or more on Sabine NWR and adjacent properties. Locations for marsh restoration would be north and NW of Browns Lake on Sabine NWR. Average water depths equal 1.5 to 2 feet deep.
- **Gulf Shoreline Stabilization**. This feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou. Gulf Shoreline Stabilization using rock foreshore dikes, offshore reefs, or segmented breakwaters. Located from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Foreshore dikes 25 to 50 feet gulfward of shore in shallow water 1 to 3 feet deep with gaps every 1,000 feet. Subaqueous rock reef placed 150 to 100 feet gulfward from shore in 2 to 5 feet depth of water. Segmented breakwaters designed similar to Holly Beach Breakwaters placed closer to shore (100 feet or closer) and with narrower gaps (approximately 250 feet long with 50 foot gaps).

SUPPLEMENTAL FRAMEWORK

This section would address the supplemental framework for Subprovinces 1-4, including the State Framework for Subprovince 2.

Subprovince 1 - Supplemental Framework (modified M2)

For Subprovince 1, the overall restoration approach is centered on the continuous re-introduction of freshwater from the Mississippi River to the portions of the Deltaic Plain through multiple freshwater diversions. Under this approach, many of the restoration features would be operated with a continuous (i.e., year-round) water flow, with discharge volumes varying according to river stages and ceasing whenever river stages are too low. Restoration strategies for the subprovince include wetland creation and hydrologic restoration via freshwater diversions, sediment diversions, and dedicated dredging and hydrologic restoration via implementation of environmental restoration projects recommended in the Mississippi River Gulf Outlet (MRGO) Study.

The relatively low subsidence rates over much of this subprovince, coupled with the relatively sparse population in much of the land to the east of the Mississippi River (outside the Greater New Orleans area), offer some of the best freshwater diversion opportunities along the coast for wetland creation and large-scale sustainable restoration. Additionally, the influence of smaller rivers in the subprovince continues to provide beneficial nourishment to freshwater marshes and wetland forests, particularly in areas north of Lakes Maurepas and Pontchartrain. Supplemental Framework features in Subprovince 1 include:

Subprovince 1 - Supplemental Framework (modified M2) - plate 30

Subprovince 1 – Supplemental Framework (modified M2)
1. 5,000 cfs diversion at Convent / Blind River.
2. 1,000 cfs diversion at Hope Canal.
3. 10,000 cfs diversion at White's Ditch.
4. 110,000 cfs diversion at American / California Bay with sediment enrichment.
5. 12,000 cfs diversion at Bayou Lamoque.
6. Increase Amite River influence by gapping dredged material banks on diversion canals.
7. Sediment delivery via pipeline at Labranche.
8. Rehabilitate Violet Siphon and post authorization change for the diversion of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands.
9. Marsh nourishment on the New Orleans East land bridge.
10. Reauthorization of the Caernarvon freshwater diversion (optimize for marsh creation).
11. Mississippi River Gulf Outlet Environmental Features and Salinity Control Study.
12. Authorized opportunistic use of the Bonnet Carre Spillway.
13. Mississippi River Delta Management Study.

- **5,000 cfs diversion at Convent / Blind River.** This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Blind River headwater. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Hope Canal**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to annual river stage hydrograph, controlled structure (current EPA project based on single box culvert).
- **10,000 cfs diversion at White's Ditch**. This feature provides for a 10,000 cfs diversion at 50 percent duration river stage into central Riv aux Chene area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **110,000 cfs diversion at American / California Bay with sediment enrichment**. This feature provides for a 110,000 cfs diversion at 50 percent duration river stage. Annual diversion corresponds to available river stage, uncontrolled diversion. Sediment enrichment assumes use of 24-inch dredge at capacity for three months. Three month yield =2,727, 000 yd^3 at an average depth of 10 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 138-ppm additional sediment in the diversion at 110,000 cfs.
- **12,000 cfs diversion at Bayou Lamoque**. This feature provides for the refurbishment and operation of the existing Bayou Lamoque diversion structures 12,000 cfs - 12,000 cfs at maximum river stage, annual diversion corresponds to annual river stage hydrograph, controlled structures require mechanical rehabilitation and operational security modifications.
- **Increase Amite River influence by gapping dredged material banks on diversion canals.** This restoration feature involves the construction of gaps in the existing dredged material banks of the Amite River diversion canal. The purpose is to introduce sediments and nutrients into Maurepas Swamp to the west of Lake Maurepas. The Maurepas Swamp is classified as a wetland forest, and contains extensive cypress swamps. The area has experienced severe deterioration due to subsidence, a lack of freshwater circulation, and a lack of nourishment through the introduction of new sediments and nutrients. Because most of the cypress are starved for nutrients and land building sediments, they are unable to keep pace with subsidence. The proposed introduction of some freshwater and sediment during high water events would facilitate organic deposition in and productivity of the swamp and prevent further swamp deterioration.
- **Sediment delivery via pipeline at Labranche.** This feature provides for sediment delivery via sediment mined from the Mississippi River. The required dredging volume would correspond to a net yield of approximately 72 wetland acres per year.
- **Rehabilitate Violet Siphon and post authorization change for the diversion of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands.** This restoration feature involves the rehabilitation of the existing Violet Siphon structure. The purposes are to improve the operation of the Violet Siphon and enhance freshwater flows into the Central Wetlands. The cypress swamps in this area have been lost due to saltwater intrusion, and the intermediate marshes are stressed by subsidence and a lack of freshwater, sediment, and nutrients. This success of this feature would be enhanced with the freshwater introductions via the Inter Harbor Navigation Channel Lock feature.

- **Marsh nourishment on the New Orleans East land bridge.** This restoration feature involves wetland creation through the dedicated dredging of sediments from offshore sources. The purpose of this feature is to create wetlands by placing dredged sediments in the shallow open waters within the land bridge separating Lakes Pontchartrain and Borgne the Labranche Wetlands. This area has experienced some wetland deterioration and loss due to erosion from wave energies in Lake Borgne. Reinforcing the land bridge between the two lakes would help maintain the salinity gradients in Lake Pontchartrain and ensure the long-term sustainability of the wetland ecosystems in the area.
- **Reauthorization of the Caernarvon freshwater diversion (optimize for marsh creation).** Since its construction in 1992, the Caernarvon structure has been operated as a salinity control feature, with freshwater introductions ranging between 1,000 cfs to 10,000 cfs. The primary purpose of the Caernarvon project has been to maintain salinity gradients in the central portion of Breton Sound. The proposed LCA restoration feature would seek a re-authorization of the Caernarvon project purpose to include wetland creation and restoration, thereby altering the project's operational framework and increasing the average freshwater introduction rate to 5,000 cfs on average. This change would help decrease the rate of wetland loss in the area.
- **Mississippi River Gulf Outlet Environmental Features and Salinity Control Study.** This restoration feature involves the implementation of the environmental restoration projects contained in the MRGO Study. In response to public concerns, environmental affects and national economic development considerations, an ongoing study is re-evaluating the viability of operation and maintenance of this project. This study would also recommend various environmental restoration projects that would reduce saltwater intrusion into Lake Pontchartrain, the Biloxi marshes, the Central Wetlands, and the Golden Triangle marshes, which has degraded large expanses of freshwater marshes and accelerated habitat switching in these areas.
- **Authorized opportunistic use of the Bonnet Carre Spillway.** This restoration feature involves freshwater introductions via the opportunistic use of the existing flood control structure at the Bonnet Carre Spillway. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carre Spillway into Lake Pontchartrain. This feature would allow for freshwater introductions to be delivered to Lake Pontchartrain and the Labranche wetlands during times of high river water levels. Thus, the river diversions would help reduce salinities in the southwest corner of Lake Pontchartrain and nourish the intermediate and brackish marshes with sediment and nutrients.
- **Mississippi River Delta Management Study.** The study is to greatly increase the deposition of Mississippi River sediments on the shallow continental shelf, while insuring navigation interests. Sediment, nutrients and fresh water would be re-directed to restore the quality and sustainability of the Mississippi River Delta Plain, its coastal wetland complex, and the Gulf of Mexico.

Subprovince 2 – Supplemental Framework (modified R1)

For Subprovince 2, the overall restoration approach is to promote a sustainable wetland ecosystem without radically altering the future salinity gradients and wetland habitat types. Freshwater re-introductions affect salinity gradients and, therefore, can result in significant ecological changes. Many of the societal and economic benefits provided by the ecosystem are currently based on the distribution of marsh types and salinity conditions that have prevailed over several decades. While the long-term goal of freshwater introductions is to ensure a healthy, productive, and sustainable coast, such features can change fisheries and wetland habitats such that local harvesters and communities can no longer realize these benefits. The question then becomes whether it is possible to minimize such potential changes, while still providing for a sustainable coastal ecosystem. Consistent with this conceptual framework, the restoration approach for this subprovince relies less on freshwater introduction and more on marsh creation using external sediment sources (off-shore and riverine sources). Although the primary features for building marsh platforms are mechanical, limited freshwater re-introductions are included to nourish existing and restored wetlands and to help ensure their long-term sustainability. The restoration approach for the subprovince also includes barrier island restoration via re-nourishment.

While there exist significant opportunities for wetland creation and large-scale sustainable restoration in this subprovince, the subprovince also presents several challenges that limit the ability to restore riverine influences to the area. The western portions of the subprovince are far removed from the existing Mississippi River and the potential to deliver substantial amounts of sediment to that area is relatively low. In addition, the subprovince is comparatively well developed, and this development influences the ability to rehabilitate wetlands near the coastal communities.

Subprovince 2 - Supplemental Framework (modified R1) – plate 31

Subprovince 2 – Supplemental Framework
1. 1,000 cfs diversion at Lac des Allemands.
2. 1,000 cfs diversion at Donaldsonville.
3. 1,000 cfs diversion at Pikes Peak.
4. 1,000 cfs diversion at Edgard.
5. Sediment delivery via pipeline at Myrtle Grove.
6. 5,000 cfs diversion at Myrtle Grove.
7. 60,000 cfs diversion at Boothville with sediment enrichment.
8. Barrier Island Restoration at Barataria Shoreline (3,000’).
9. Reauthorization of Davis Pond.
10. Marsh creation at Wetland Creation and Restoration Feasibility Study sites.
11. Mississippi River Delta Management Study.
12. Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to implementation).

- **1,000 cfs diversion at Lac des Allemands**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Becnel. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Donaldsonville**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into upper Bayou Verret. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Pikes Peak**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Bayou Chevreuil. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **1,000 cfs diversion at Edgard**. This feature provides for a 1,000 cfs diversion at 50 percent duration river stage diverted into Lac des Allemands through Bayou Fortier. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **Sediment delivery via pipeline at Myrtle Grove**. This feature provides for sediment delivery via sediment mined from Mississippi River. Required dredging volume corresponding to a net yield of approximately 29 wetland acres per year.
- **5,000 cfs diversion at Myrtle Grove**. This feature provides for a 5,000 cfs diversion at 50 percent duration river stage diverted into the Bayou Dupont area. Annual diversion corresponds to annual river stage hydrograph, controlled structure.
- **60,000 cfs diversion at Boothville with sediment enrichment.** This feature provides for a 60,000 cfs diversion at 50 percent duration river stage into the Yellow Cotton / Hospital Bay area. Annual diversion corresponds to annual river stage hydrograph, uncontrolled diversion.
- **Barrier Island restoration at Barataria Shoreline.** Mining of offshore sediment sources to reestablish barrier islands. Based on designs developed in the LCA Barrier Island Restoration study. Option assumes a 3,000-foot island footprint.
- **Reauthorization of Davis Pond.** Since its construction in 2002, the Davis Pond structure has been operated as a salinity control measure, with freshwater introductions ranging between 1,000 cfs to 10,000 cfs. The primary purpose of the Davis Pond project has been to maintain salinity gradients in the central portion of the Barataria Basin. The proposed LCA restoration feature would seek a re-authorization of the Davis Pond project purpose to include wetland creation and restoration, thereby altering the project's operational framework and increasing the freshwater introduction rate to 5,000 cfs on average.

  Prior to the implementation of the project, the area experienced wetland deterioration due to subsidence, a lack of freshwater circulation, saltwater intrusion, and a lack of nourishment through the introduction of new sediments and nutrients. Today, wetland degradation continues due to subsidence and a paucity of sediment and nutrients to nourish the wetland communities.
- **Marsh creation at Wetland Creation and Restoration Feasibility Study sites**. Sediment mined from Mississippi River placed in the sites along Bayou Lafourche, required dredging volume corresponding to a net yield of approximately 220 wetland acres per year.
- **Mississippi River Delta Management Study.** The study is to greatly increase the deposition of Mississippi River sediments on the shallow continental shelf, while insuring navigation interests. Sediment, nutrients and fresh water would be re-directed to restore

the quality and sustainability of the Mississippi River Delta Plain, its coastal wetland complex, and the Gulf of Mexico.

- **Third Delta (**Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to implementation**).** This feature provides for a 120,000 cfs diversion at Bayou Lafourche. Approximately 240,000 cfs at maximum river stage diverted into a newly constructed conveyance channel (parallel to Bayou Lafourche), diversion corresponds to annual river stage hydrograph, diverted flow would be divided equally between the Barataria and Terrebonne hydrologic basins, controlled structure. Sediment enrichment assumes use of 30-inch dredge at capacity for three months. Three month yield = 6,293, 000 yd^3 at an average depth of 5 feet with 50 percent compaction and 80 percent retention. This corresponds to approximately 175-ppm additional sediment in the diversion at 200,000 cfs.

Subprovince 3 - Supplemental Framework (modified R1)

For Subprovince 3, the overall restoration approach is centered on reducing wetland losses and maximizing wetland creation through better management of the Atchafalaya River water flows. The Atchafalaya River is a distributary of the Mississippi River and is, in essence, a huge freshwater diversion that currently supports delta building and wetland creation at the Wax Lake Outlet and at the mouth of the Lower Atchafalaya River. In addition, the Atchafalaya River nourishes the wetlands in the Teche/Vermilion Basin, located in the western portion of the subprovince. As a result, this basin contains some of the healthiest wetlands in Louisiana's coastal area, fueled by the inputs of sediments and nutrients from the Atchafalaya River. Thus, the LCA Ecosystem Restoration Study proposes few rehabilitation features for wetland areas immediately adjacent to and areas to the west of the Atchafalaya River, where wetland communities are predominantly healthy. Instead, the study focuses attention on 1) maximizing the on-going deltaic development at the Wax Lake Outlet and the mouth of the Lower Atchafalaya River, 2) maximizing Atchafalaya River flows to the degraded wetlands that lie on the fringe of its riverine influence, primarily the Terrebonne Basin wetlands, which are located to the far east of the Atchafalaya River and to the west of Bayou Lafourche, and 3) reducing marine processes from the Gulf of Mexico on the gulf shorelines. The eastern half of the Terrebonne Basin is the furthest removed from any active river system and is experiencing some of the highest land loss rates within the Deltaic Plain, due mainly to a high subsidence rate, altered hydrology associated with the damming of Bayou Lafourche, and the dredging of oil and gas canals and the Houma Navigation Canal. Land loss in Subprovince 3 is so severe that it experiences the highest land loss along the coast.

The ultimate performance of almost every individual feature in Subprovince 3 is closely tied to the successful implementation of other restoration features in the subprovince. For example, one restoration feature involves the construction and operation of the Houma Navigation Canal Lock to stem the rate at which Atchafalaya River flows in the Terrebonne Basin are shunted to the Gulf of Mexico, bypassing wetlands in need of freshwater, nutrients and sediments. With a reduced rate, other restoration features to the north of the Houma Navigation Canal Lock can use the recouped freshwater and introduce it into wetland areas of critical concern. Without the

Houma Navigation Canal Lock, the performance of several restoration features in the subprovince is compromised and the synergistic benefits gained from their collective implementation are reduced. Supplemental Framework features in Subprovince 3 include:

Subprovince 3 - Supplemental Framework (modified R1) - plate 32

Subprovince 3 – Supplemental Framework (modified R1)
1. Bayou Lafourche 1,000 cfs pump.
2. Relocate the Atchafalaya navigation channel.
3. Increase sediment transport down Wax Lake Outlet.
4. Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands.
5. Convey Atchafalaya River water to Terrebonne marshes.
6. Freshwater introduction via Blue Hammock Bayou.
7. Penchant Basin Plan.
8. Maintain northern shore of East Cote Blanche Bay
9. Rebuild Pointe Chevreuil reef.
10. Restore Terrebonne barrier islands.
11. Multipurpose operation of the Houma Navigation Canal (HNC) Lock.
12. Maintain land bridge between Caillou Lake and Gulf of Mexico.
13. Stabilize gulf shoreline
14. Maintain land bridge between Bayous Dularge and Grand Caillou.

- **Bayou Lafourche 1,000 cfs pump.** A flow of 1000 cfs would be pumped into Bayou Lafourche. The targeted wetland benefit area is the area between Bayous Lafourche and Terrebonne, south of the GIWW. The flow would be continuous and would freshen the wetlands and would reduce loss rates.
- **Relocate the Atchafalaya navigation channel.** This feature consists of relocating the Atchafalaya navigation channel. The Navigation Channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the Channel and using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the delta lobes.
- **Increase sediment transport down Wax Lake Outlet.** Increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet (WLO) flows pass over the relatively shallow Six Mile Lake before entering the outlet. This feature would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby increasing more bed load sediments to be transported to the WLO delta. Increased delta growth was projected by the LSU CELSS Western Bays Model.
- **Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands.** This proposal would alter the ORCS operational framework with a goal of increasing the sediment load to be transported by the Atchafalaya River. An approximate 20 percent increase in delta growth was proposed as the feature objective but would be refined upon detailed evaluation of the feature. Detailed studies of this proposal would include determination of impacts (beneficial and

adverse) to the interior of the Atchafalaya Basin, the degree to which flow and sediment distributions would be required, and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red and Atchafalaya Rivers.

- **Convey Atchafalaya River water to Terrebonne marshes.** Increase Atchafalaya River flows to Terrebonne Basin by a diversion in the Avoca Island Levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma. Ideally, half of Bayou Shaffer flow, or more, would be diverted (via an open unstructured cut through the levee) into Avoca Lake to maximize land building. The percent flow diverted would be reduced if high water level impacts in the Penchant marshes would be too great. A constriction structure in Bayou Shaffer would be installed downstream of the levee cut to force flow into Avoca Lake. Several new channels connecting the eastern portions of Avoca Lake with Bayou Chene would be constructed to facilitate the distribution of sediments (land-building) across a wider portion of the lake bottom. Introduced flows leaving Avoca Lake would be readily carried southward down Bayou Penchant, increasing its sediment load, compared to the existing conditions where water has to back-up to Bayou Penchant through the Avoca Island Cutoff Channel. In lieu of a diversion from Bayou Shaffer into Avoca Lake, an alternative might be to partial or fully breach the Avoca Island Extension Levee where Bayou Shaffer runs adjacent to the Avoca Island Cutoff Canal. This cut would also involve an open armored channel.

  In conjunction with the Bayou Shaffer diversion, sections of eroded dredged material banks along the GIWW would be repaired to contain flows for more efficient delivery to areas of need further east and to halt boat wake-induced erosion of shoreline marshes.

  In conjunction with the above features, and to better carry water eastward to brackish areas of need, the GIWW constrictions would be enlarged. In Bayou Chene, the channel is roughly 12,000 sq. feet. But between Bayou Black and Bay Wallace, the channel is reduced to 5,500 sq. feet. The most severe constriction is in Houma where cross-section is reduced to as little as 2,200 sq. feet at the Bayou Terrebonne junction. An initial concept is to construct and maintain an 8,000 sq. foot channel through Houma. This concept is very closely linked with project number 5a above and would be considered only if that project shows that the presently available freshwater can be fully utilized through features to introduce it into needy marshes south of the GIWW. This project would involve dredging to enlarge channel cross-section and relocations of businesses and utilities, together with bridge modifications as needed. The Houma GIWW tunnel may limit the degree to which the channel can be enlarged at the tunnel location.
- **Freshwater introduction via Blue Hammock Bayou.** Increase Atchafalaya Flow to SW Terrebonne via Blue Hammock Bayou. The project would increase the distribution of Atchafalaya flows in Fourleague Bay to Lake Merchant wetlands by increasing the cross-section of Blue Hammock Bayou. Marsh would be created with material dredged. Grand Pass and Buckskin Bayou, the outlets of Lake Merchant, would be reduced in cross section to increase the retention of Atchafalaya nutrients, sediment, and freshwater.
- **Penchant Basin Plan.** Reduce excessive water levels in the upper Penchant Subbasin by implementing the Penchant Basin Plan. The Penchant Basin Plan would increase the

efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods. Increased outlet capacities would utilize the flows to increase the circulation and retention to wetlands in the more tidal zone below the large fresh floating marsh zone. Wetlands losses would be reduced in both zones (LSU CELSS model results).

- **Maintain northern shore of East Cote Blanche Bay.** Protect North shore of East Cote Blanche Bay from Point Marone to Jackson Bayou. Approximately 23,600 feet of bay shoreline would be stabilized to protect the interior wetland water circulation patterns in the Cote Blanche Wetlands CWPPRA project. The project was designed to increase the retention time of the Atchafalaya flows moving from the GIWW to East Cote Blanche Bay. Shoreline erosion is thought to have increased with dredging of shell reefs between the bay and gulf.
- **Rebuild Point Chevreuil Reef.** This feature provides for rebuilding historic Point Chevreuil Reef toward Marsh Island. Rehabilitate the Bayou Sale natural levee between Point Chervil and the gulf. The natural levee would be rebuilt in the form of a shallow sub aqueous platform, small islands, and/or reefs. The historic shell reefs were removed by shell dredging. The feature would be about 12 miles long and would deflect some of Atchafalaya flow and sediments from entering East Cote Blanche Bay resulting in slightly higher salinities in the bay. Overall, this feature would restore some semblance of historic hydrologic conditions in the Teche/Vermilion Basin.
- **Restore Terrebonne barrier islands.** This feature provides for the restoration of the Timbalier and Derrieres barrier island chains (Alternative a). This would simulate the 1890 condition with fewer breaches than now. The islands would be widened to 600m and the dune crest elevation would be 2.7 m (NGVD).
- **Multipurpose operation of the Houma Navigation Canal (HNC) Lock.** Multi-purpose operation of the Houma Navigation Canal Lock and related Morganza to the Gulf Hurricane Protection Project features. Improve the distribution of Atchafalaya flows through the HNC to the west in Falgout Canal, to the marshes east and west of the HNC, to the marshes south of the Lake Boudreaux Basin, and to the Grand Bayou marshes east of Bayou Point Au Chien. Structures would be operated during periods of low freshwater flows to reduce intrusion of high salinity water into low salinity wetlands.
- **Maintain land bridge between Caillou Lake and the Gulf of Mexico.** Maintain the land bridge between the gulf and Caillou Lake by shore protection in Grand Bayou DuLarge to minimize salinity intrusion. This project would involve 43,000 feet of rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou DuLarge, where a new channel is threatening to breach the bayou bank and allow the establishment of a new connection with Caillou Lake. Some gulf shore armoring would likely be needed to protect these features from erosion on the gulf shoreline. A more systemic and comprehensive solution would involve a much greater amount of gulf shoreline armoring, especially toward the west where shoreline retreat and loss of shoreline oyster reefs has allowed for increased water exchange between the gulf and the interior waterbodies (between Bay Junop and Caillou Lake). Some of the newly opened channels would be closed to restore historic cross-sections of exchange points. By reducing marine influences in these interior areas, these features might also allow increased riverine influences from Four League Bay to benefit area marshes.

- **Stabilize gulf shoreline.** This feature provides for stabilizing the gulf shoreline of Point Au Fer Island. Stabilize 81,500 feet of the gulf shoreline of Point Au Fer I to prevent direct connections between the gulf and interior water bodies. The gulf shoreline erosion would be arrested along the island thereby reducing the direct losses from the erosion. Indirectly, island marsh loss would be reduced by preventing the interior water circulation avenues from being connected directly to the gulf rather than Atchafalaya Bay and Fourleague Bay. The fresh nutrient and sediment rich bay waters provide for wetland needs much better than the high salinity gulf waters.
- **Maintain land bridge between Bayous Dularge and Grand Caillou.** Construct a land bridge between Bayous DuLarge and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining waterbodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous 300-foot-wide and 21,000-foot-long berm of "high marsh" extending from Bayou Grand Caillou to Bayou DuLarge (leaving Bayou Sauveur open). This berm would separate the higher healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.

<u>Subprovince 4 - Supplemental Framework (modified E2)</u>

For Province 4, the overall restoration approach is centered on reducing salinity impacts on coastal wetlands. Under this approach, salinity controls (e.g., existing and newly constructed salinity control structures) around Calcasieu Lake and the eastern portion of Sabine Lake would be established and/or modified to reduce tidal influences between the Gulf of Mexico and the interior coastal wetlands. In addition, marsh creation efforts would be undertaken in interior open water surrounding Calcasieu Lake, and excess freshwater would be diverted south of Highway 82 to reduce the ponding of water on wetlands within the Mermentau Lakes Subbasin, and more importantly, to reduce the salinities in the Chenier subbasin wetlands. Thus, the restoration strategies for the subprovince are wetland creation via beneficial use/dedicated dredging of sediments, and hydrologic restoration, which would reduce wetland losses and improve wetland functionality and sustainability in the coastal marshes.

There are several opportunities that may facilitate wetland restoration in this subprovince. First, subsidence rates in the subprovince are comparatively low, therefore tidal influences and saltwater intrusion remain the primary factors adversely impacting the long-term wetland sustainability. Second, dredged material is readily available from navigation channels, especially the Calcasieu Ship Channel, to create new wetlands and nourish existing ones. Supplemental Framework features in Subprovince 4 include:

<u>Subprovince 4- Supplemental Framework (modified E2) – plate 33</u>

Subprovince 4 – Supplemental Framework (modified E2)
1. Salinity control at Oyster Bayou.
2. Salinity control at Long Point Bayou.
3. Salinity control at Black Lake Bayou.
4. Salinity control at Alkali Ditch.
5. Modify existing Cameron-Creole Watershed Control structures.
6. East Sabine hydrologic restoration.
7. Salinity control at Black Bayou.
8. Salinity control at Highway 82 Causeway.
9. Freshwater introduction at Pecan Island.
10. Freshwater introduction at Rollover Bayou.
11. Freshwater introduction at Highway 82.
12. Freshwater introduction at Little Pecan Bayou.
13. Freshwater introduction at South Grand Chenier.
14. Gulf shoreline stabilization.
15. Calcasieu ship channel beneficial use.
16. Black Bayou Bypass culverts.
17. Chenier Plain Freshwater Management and Allocation Reassessment.

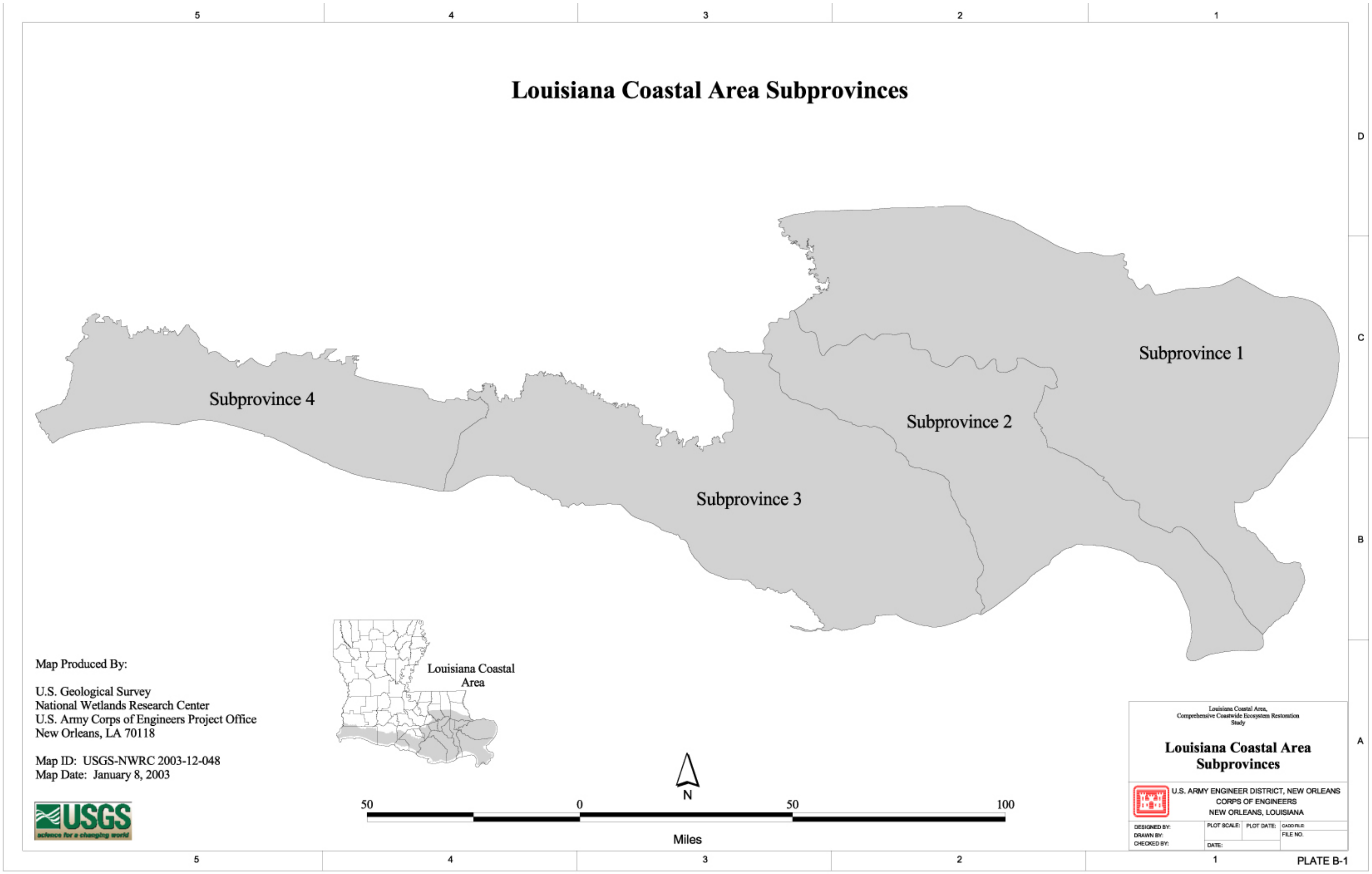
- **Salinity control at Oyster Bayou**. Salinity control in Oyster Bayou with a gated structure or rock weir. Location in Oyster Bayou about 1 mile west of Calcasieu Ship Channel 100-150 feet wide X 10 feet deep; with an approximately 15-20 feet wide X 4 feet deep boat bay.
- **Salinity control at Long Point Bayou**. Salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27 west of Calcasieu Ship Channel (Existing dimensions equal 40 feet wide X 5 feet deep; structure approximate dimensions are 10 to 15 feet wide X 4 feet deep boat bay).
- **Salinity control at Black Lake Bayou.** Salinity control in Black Lake Bayou with gated structure or rock weir with boat bay. Location in Black Lake Bayou north of Hackberry near Calcasieu Ship Channel (Existing bayou dimensions are approximately 150 feet wide X10 feet deep; gated structure or rock weir approximate dimensions equal 25 to 50 feet wide X 6 to 8 feet deep boat bay).
- **Salinity control at Alkali Ditch**. Salinity control at the Alkali Ditch, northwest of Hackberry, LA at the GIWW, with gated structure or rock weir with barge bay (Existing dimensions are approximately 150 to 200 feet wide X 8 to10 feet deep; structure or weir with approximate dimensions 70 feet wide X 8 feet deep.
- **Modify existing Cameron-Creole Watershed Control Structures**. The Cameron-Creole watershed project constructed in 1989 consists of 5 large concrete water control structures and a 16 mile-long levee along the shoreline of Calcasieu Lake. Three of the five structures (Grand Bayou, Bois Connine Bayou, and Lambert Bayou) are adjustable structure with slide gates and the remaining two (Mangrove Bayou and No Name Bayou) are fixed crest weir structures. The fixed crest weir sill heights may be set too high. This higher setting could be contributing to the impoundment problem within Cameron-Creole marshes adjacent to those structures. If the weir sills for these two structures could be

modified to lower weir crests reduced impoundment, greater water flow and increased fisheries access independent of salinity control at Calcasieu Pass.

- **East Sabine hydrologic restoration**. East Sabine Lake Hydrologic Restoration Project between Sabine Lake and Sabine NWR Pool 3; salinity control structures at Willow Bayou, Three Bayou, Greens Bayou and Right Prong of Black Bayou, terracing, Sabine Lake shoreline protection, & smaller structures.
- **Salinity control at Black Bayou**. Salinity control structure with boat bay at mouth of Black Bayou (either gated structure or a rock weir), located at the intersection of Black Bayou and the northeastern shoreline of Sabine Lake (Existing bayou dimensions are 150 to 200 feet wide X 10 feet deep).
- **Salinity control at Highway 82 Causeway**. This feature provides rock weir at Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass and the Sabine-Neches Waterway Existing dimensions equal approximately 3,400 feet wide by approximately 4 feet deep except at the approximate 10 feet deep center channel.
- **Freshwater introduction at Pecan Island**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater introduction at Rollover Bayou**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin.
- **Freshwater introduction at Highway 82**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge.
- **Freshwater introduction at Little Pecan Bayou.** This feature provides for Movement of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge.
- **Freshwater introduction at South Grand Chenier**. This feature provides for movement of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou Watershed.
- **Gulf Shoreline Stabilization**. This feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou. Gulf Shoreline Stabilization using rock foreshore dikes, offshore reefs, or segmented breakwaters. Located from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Foreshore dikes 25 to 50 feet gulfward of shore in shallow water 1 to 3 feet deep with gaps every 1,000 feet. Subaqueous rock reef placed 150 to 100 feet gulfward from shore in 2 to 5 feet depth of water. Segmented breakwaters designed similar to Holly Beach Breakwaters placed closer to shore (100 feet or closer) and with narrower gaps (approximately 250 feet long with 50 feet gaps).
- **Calcasieu Ship Channel Beneficial Use**. This feature provides for beneficial use of dredged material from the Calcasieu Ship Channel.
- **Black Bayou Bypass culverts.** This feature provides for the replacement of the Calcasieu Lock in the GIWW west of the Hwy 384 Bridge and use old lock for freshwater introduction to the upper Calcasieu estuary from the Mermentau Basin. This feature also provides for freshwater introduction via the Black Bayou Culverts feature at the intersection of Black Bayou and Hwy 384.

- **Chenier Plain Freshwater Management and Allocation Reassessment.** This restoration feature requires detailed investigations involving water allocation needs and trade-off analysis in the eastern Chenier Plain, including the Teche/Vermillion Basin, to provide for wetland restoration, and support continued agriculture and navigation in the region.

The following pages (A-70 to A-104) present the plates for this attachment. The locations of features identified in the following plates were used for costing purposes. The specific locations of restoration features will be identified during the preparation of detailed project implementation reports


Louisiana Coastal Area Subprovinces
Subprovince 1
Subprovince 2
Subprovince 3
Subprovince 4
Louisiana Coastal Area
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-048
Map Date: January 8, 2003
USGS
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Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Louisiana Coastal Area
Subprovinces
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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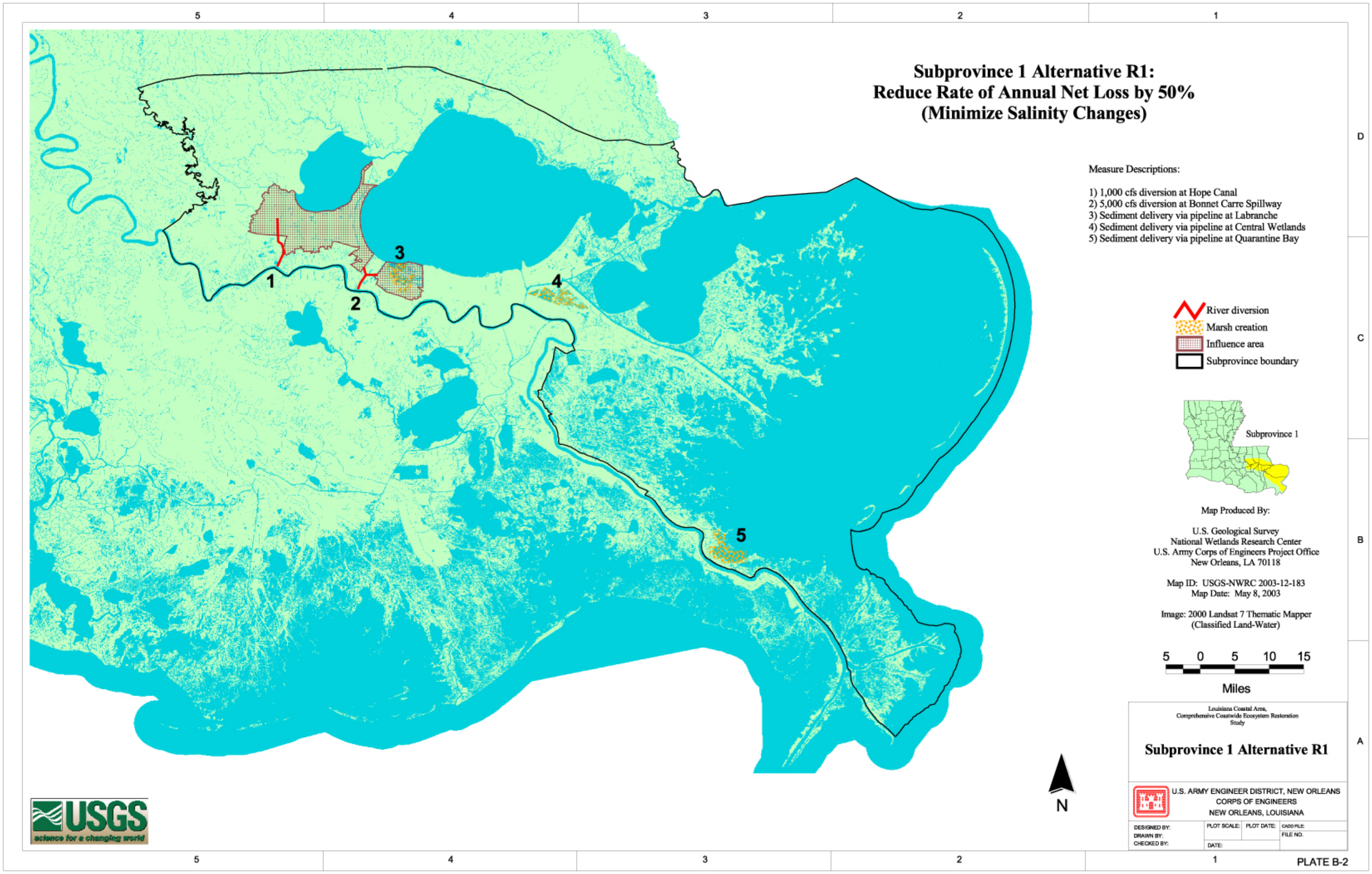
PLATE B-1



Subprovince 1 Alternative R1:
Reduce Rate of Annual Net Loss by 50%
(Minimize Salinity Changes)
Measure Descriptions:
1) 1,000 cfs diversion at Hope Canal
2) 5,000 cfs diversion at Bonnet Carre Spillway
3) Sediment delivery via pipeline at Labranche
4) Sediment delivery via pipeline at Central Wetlands
5) Sediment delivery via pipeline at Quarantine Bay
River diversion
Marsh creation
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-183
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
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Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative R1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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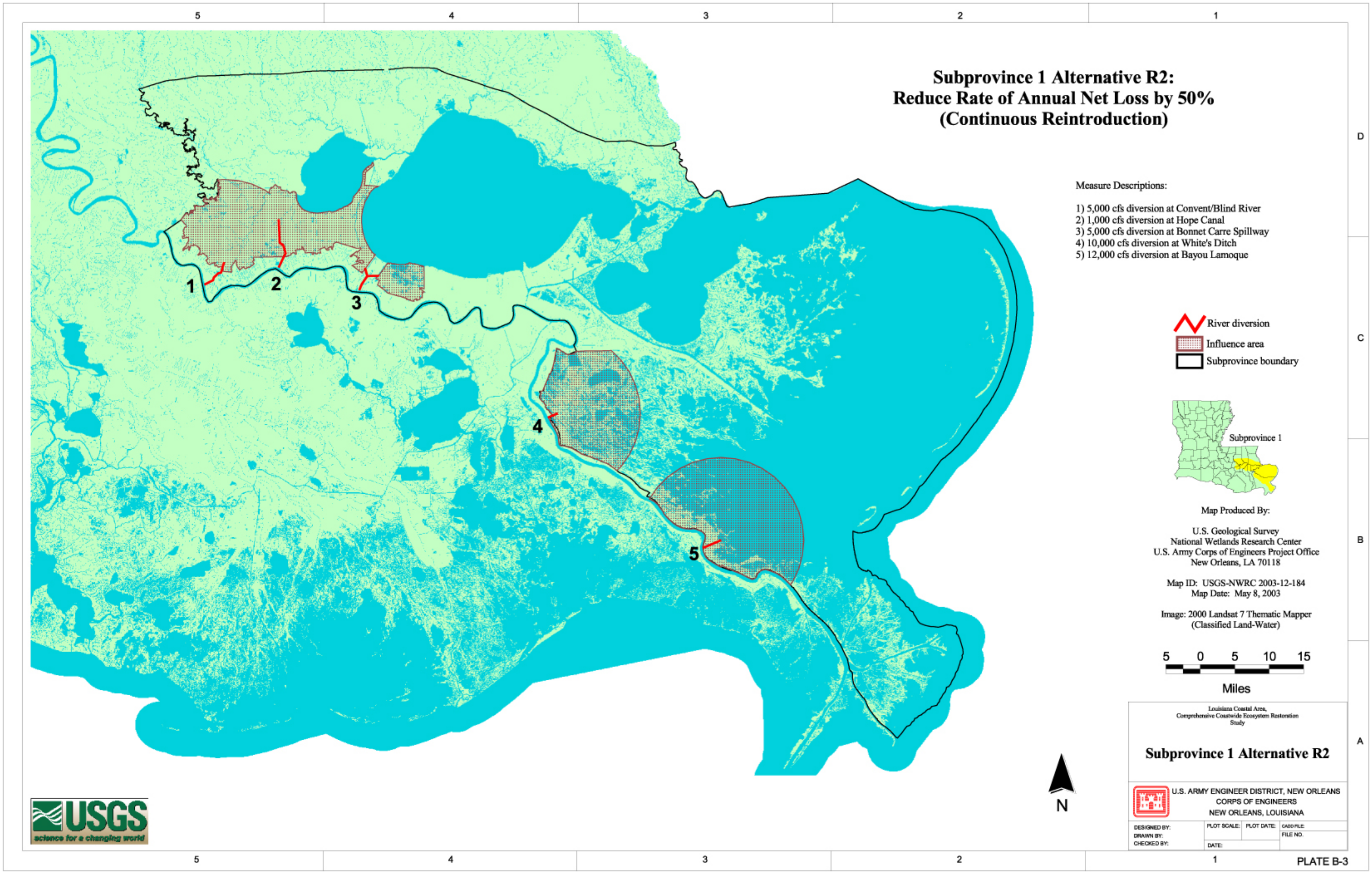
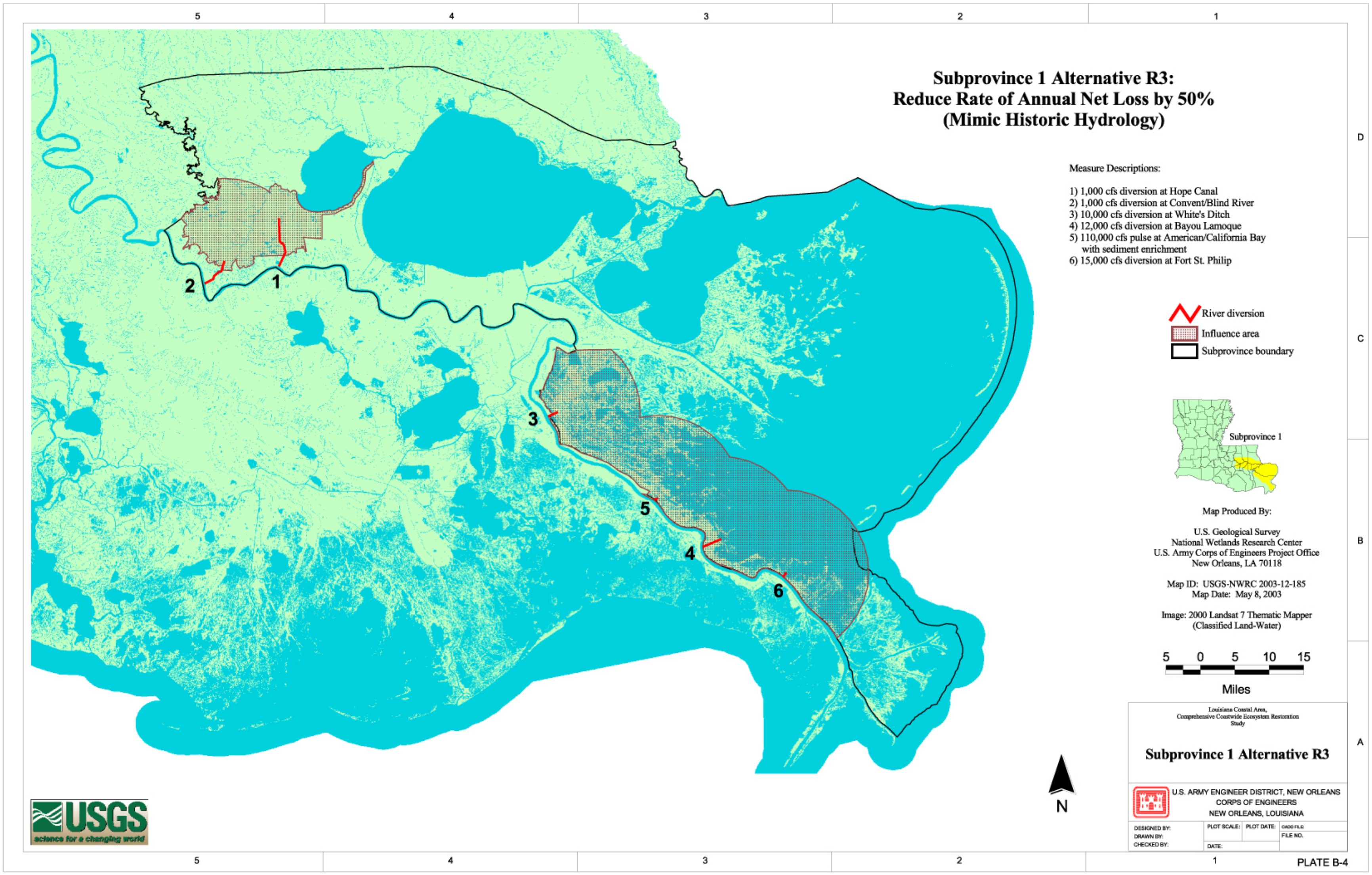
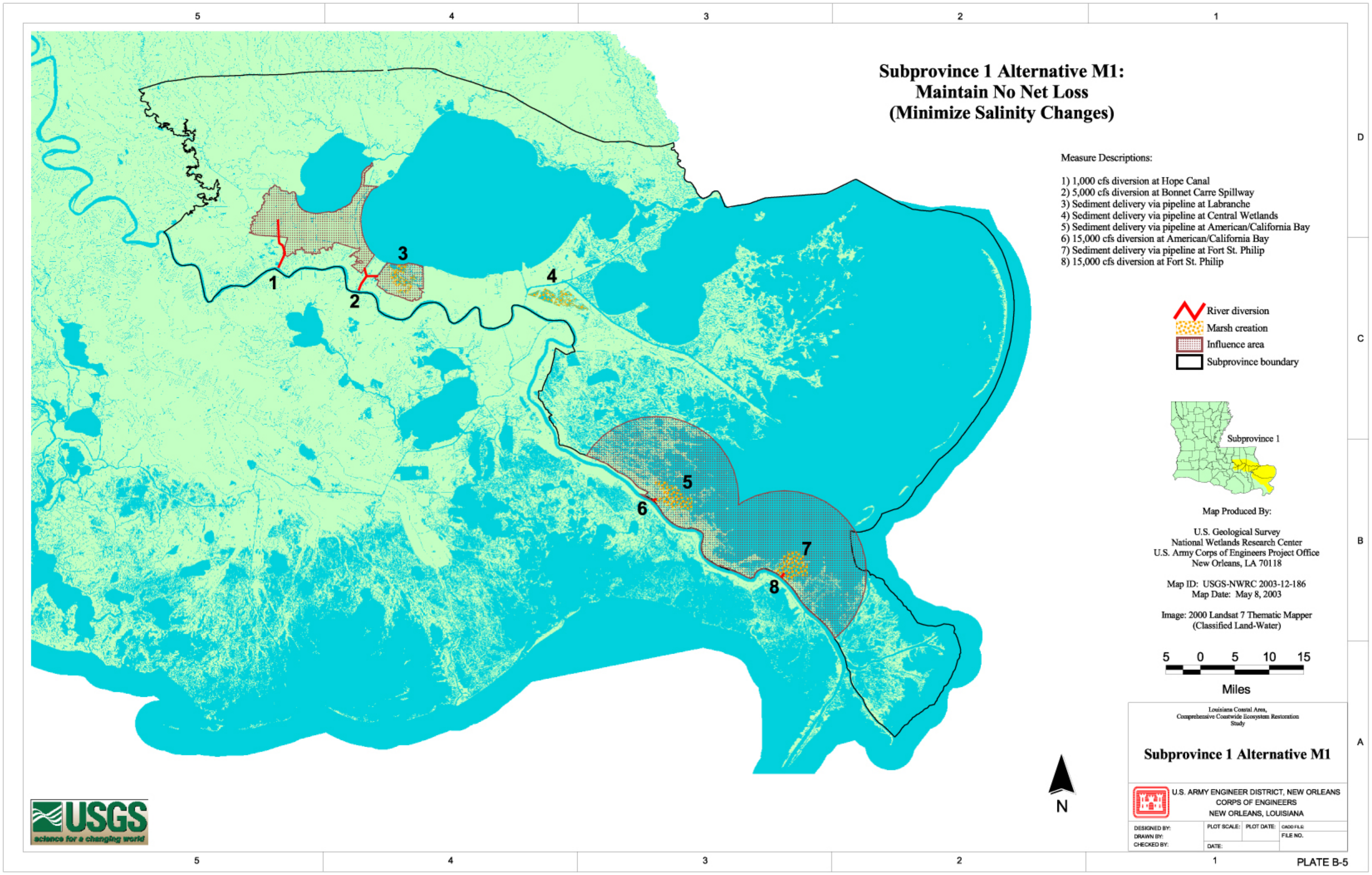
PLATE B-2
USGS
science for a changing world


Subprovince 1 Alternative R2:
Reduce Rate of Annual Net Loss by 50%
(Continuous Reintroduction)
Measure Descriptions:
1) 5,000 cfs diversion at Convent/Blind River
2) 1,000 cfs diversion at Hope Canal
3) 5,000 cfs diversion at Bonnet Carre Spillway
4) 10,000 cfs diversion at White's Ditch
5) 12,000 cfs diversion at Bayou Lamoque
River diversion
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-184
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative R2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
N
USGS
science for a changing world
PLATE B-3


Subprovince 1 Alternative R3:
Reduce Rate of Annual Net Loss by 50%
(Mimic Historic Hydrology)
Measure Descriptions:
1) 1,000 cfs diversion at Hope Canal
2) 1,000 cfs diversion at Convent/Blind River
3) 10,000 cfs diversion at White's Ditch
4) 12,000 cfs diversion at Bayou Lamoque
5) 110,000 cfs pulse at American/California Bay with sediment enrichment
6) 15,000 cfs diversion at Fort St. Philip
River diversion
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-185
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 1 Alternative R3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
N
USGS
science for a changing world
PLATE B-4



Subprovince 1 Alternative M1:
Maintain No Net Loss
(Minimize Salinity Changes)
Measure Descriptions:
1) 1,000 cfs diversion at Hope Canal
2) 5,000 cfs diversion at Bonnet Carre Spillway
3) Sediment delivery via pipeline at Labranche
4) Sediment delivery via pipeline at Central Wetlands
5) Sediment delivery via pipeline at American/California Bay
6) 15,000 cfs diversion at American/California Bay
7) Sediment delivery via pipeline at Fort St. Philip
8) 15,000 cfs diversion at Fort St. Philip
River diversion
Marsh creation
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-186
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative M1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
DATE:
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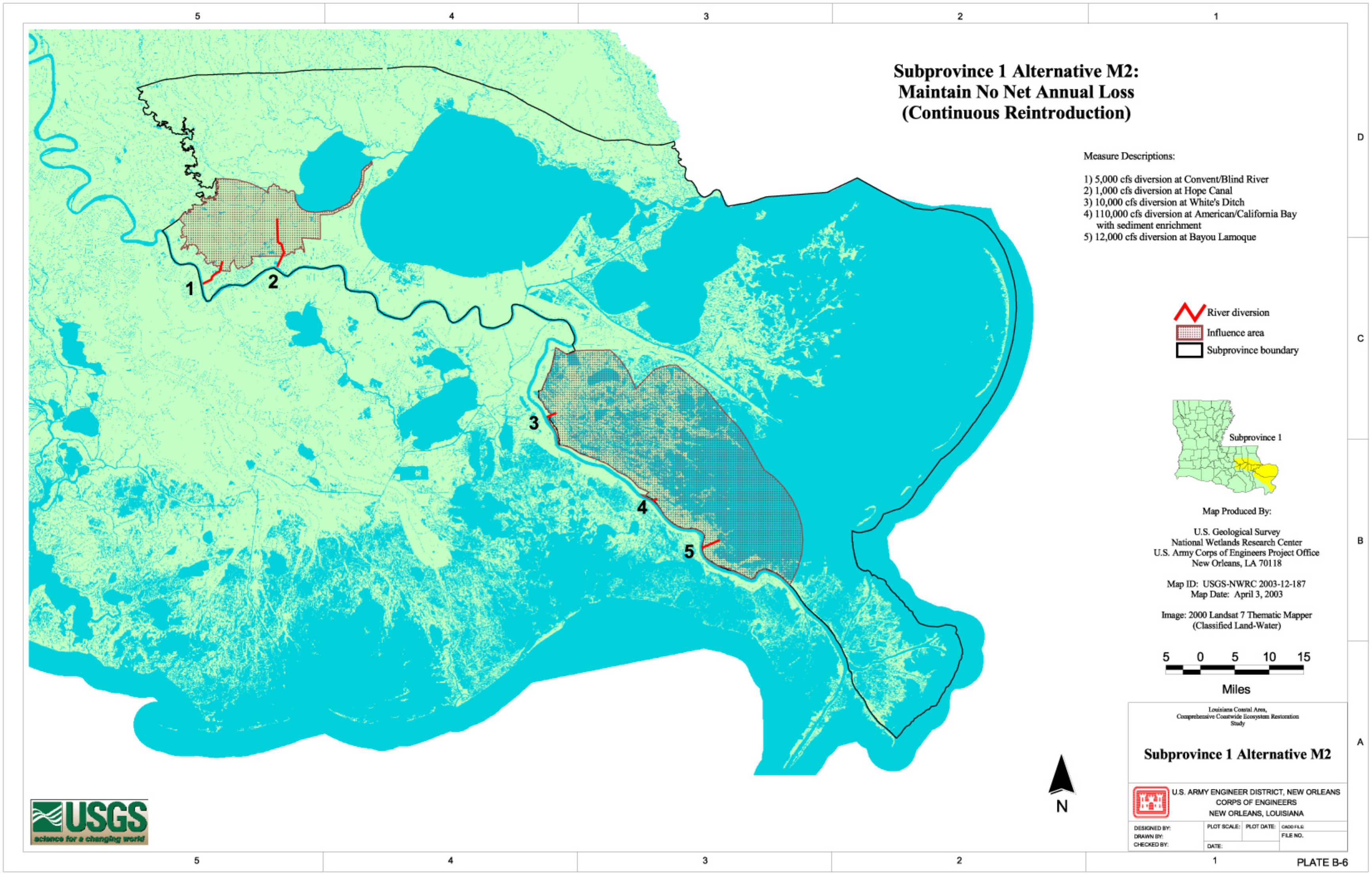
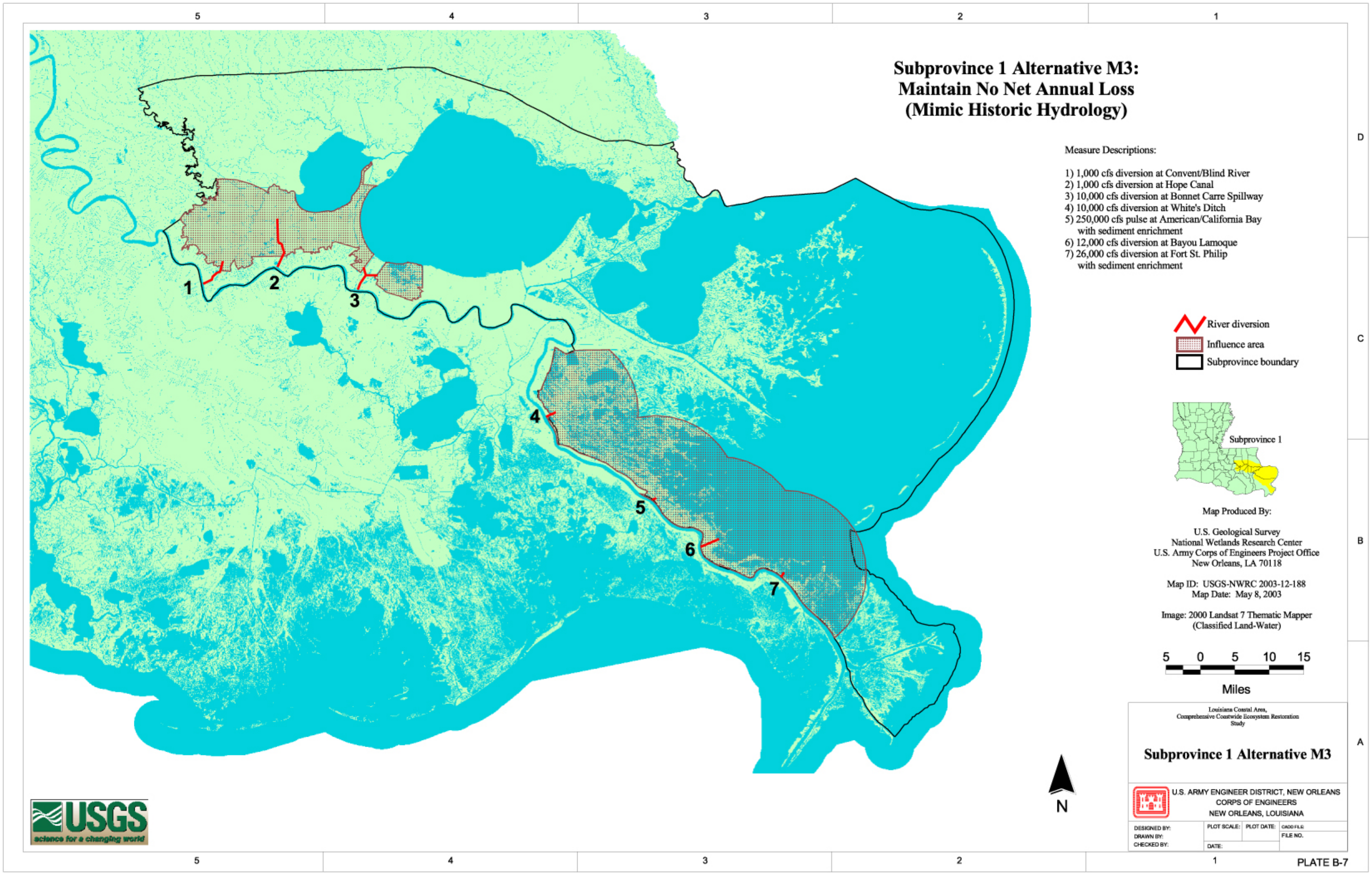
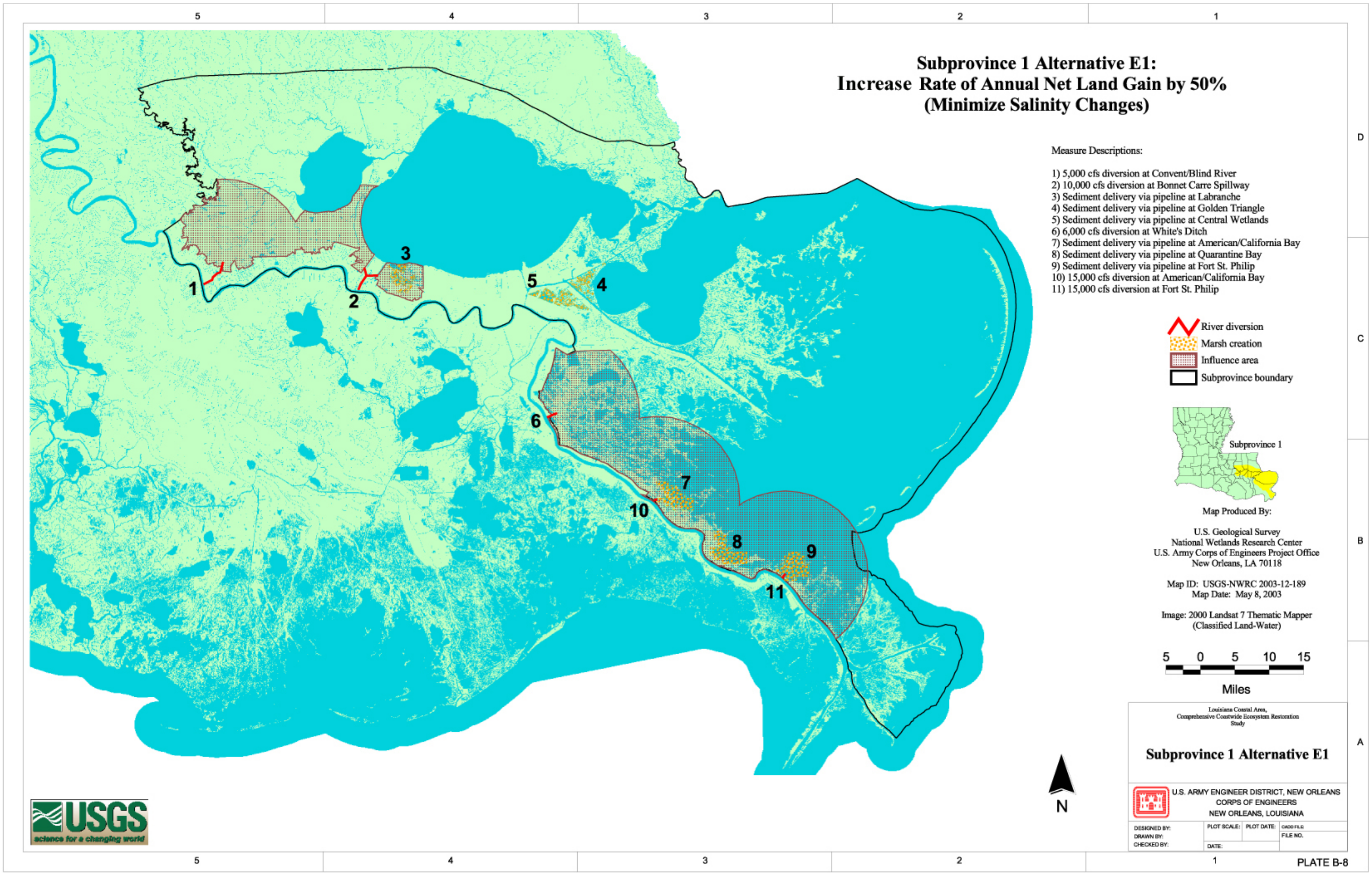
FILE NO.
N
PLATE B-5
USGS
science for a changing world



Subprovince 1 Alternative M2:
Maintain No Net Annual Loss
(Continuous Reintroduction)
Measure Descriptions:
1) 5,000 cfs diversion at Convent/Blind River
2) 1,000 cfs diversion at Hope Canal
3) 10,000 cfs diversion at White's Ditch
4) 110,000 cfs diversion at American/California Bay with sediment enrichment
5) 12,000 cfs diversion at Bayou Lamoque
1
2
3
4
5
River diversion
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-187
Map Date: April 3, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative M2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
DATE:
CADD FILE:
FILE NO.
PLATE B-6


Subprovince 1 Alternative M3:
Maintain No Net Annual Loss
(Mimic Historic Hydrology)
Measure Descriptions:
1) 1,000 cfs diversion at Convent/Blind River
2) 1,000 cfs diversion at Hope Canal
3) 10,000 cfs diversion at Bonnet Carre Spillway
4) 10,000 cfs diversion at White's Ditch
5) 250,000 cfs pulse at American/California Bay with sediment enrichment
6) 12,000 cfs diversion at Bayou Lamoque
7) 26,000 cfs diversion at Fort St. Philip with sediment enrichment
River diversion
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-188
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative M3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
DATE:
CADD FILE:
FILE NO.
USGS
science for a changing world
PLATE B-7



Subprovince 1 Alternative E1:
Increase Rate of Annual Net Land Gain by 50%
(Minimize Salinity Changes)
Measure Descriptions:
1) 5,000 cfs diversion at Convent/Blind River
2) 10,000 cfs diversion at Bonnet Carre Spillway
3) Sediment delivery via pipeline at Labranche
4) Sediment delivery via pipeline at Golden Triangle
5) Sediment delivery via pipeline at Central Wetlands
6) 6,000 cfs diversion at White's Ditch
7) Sediment delivery via pipeline at American/California Bay
8) Sediment delivery via pipeline at Quarantine Bay
9) Sediment delivery via pipeline at Fort St. Philip
10) 15,000 cfs diversion at American/California Bay
11) 15,000 cfs diversion at Fort St. Philip
River diversion
Marsh creation
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-189
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative E1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
CADD FILE:
FILE NO.
DATE:
PLATE B-8
USGS
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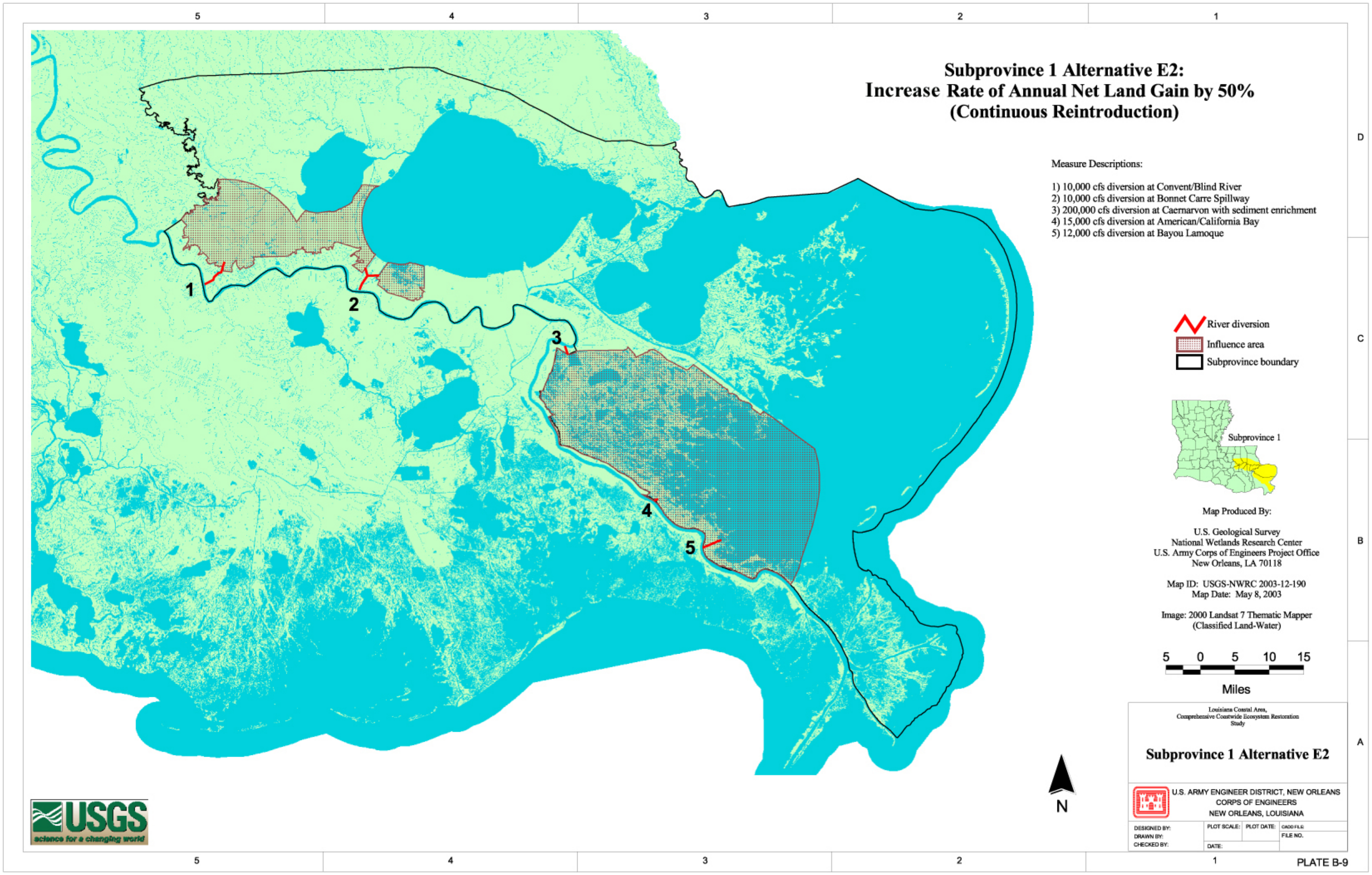
N



Subprovince 1 Alternative E2:
Increase Rate of Annual Net Land Gain by 50%
(Continuous Reintroduction)
Measure Descriptions:
1) 10,000 cfs diversion at Convent/Blind River
2) 10,000 cfs diversion at Bonnet Carre Spillway
3) 200,000 cfs diversion at Caernarvon with sediment enrichment
4) 15,000 cfs diversion at American/California Bay
5) 12,000 cfs diversion at Bayou Lamoque
1
2
3
4
5
River diversion
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-190
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
N
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 1 Alternative E2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
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PLOT SCALE:
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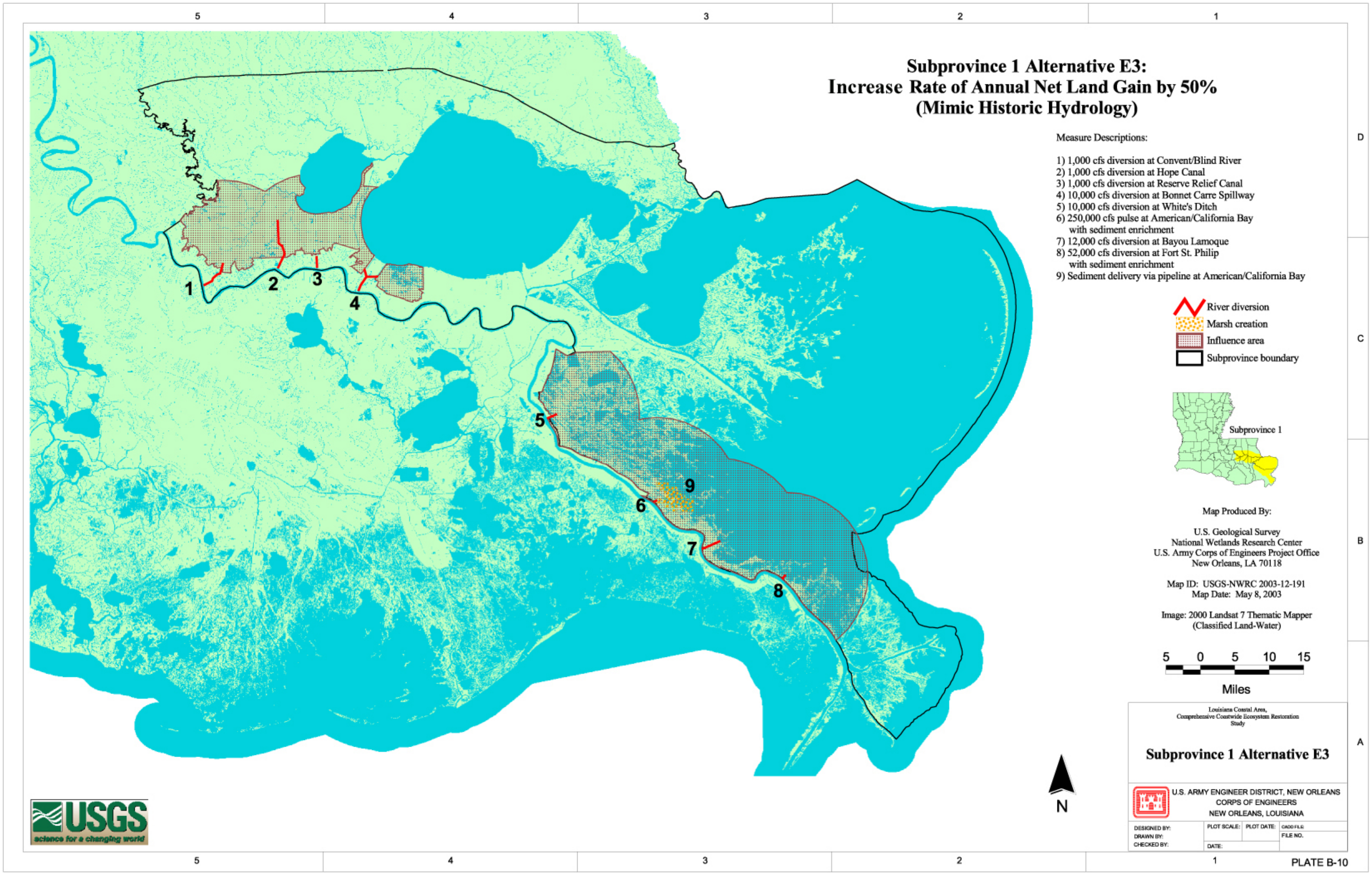
CADD FILE:
FILE NO.
5
4
3
2
1
D
C
B
A
PLATE B-9


Subprovince 1 Alternative E3:
Increase Rate of Annual Net Land Gain by 50%
(Mimic Historic Hydrology)
Measure Descriptions:
1) 1,000 cfs diversion at Convent/Blind River
2) 1,000 cfs diversion at Hope Canal
3) 1,000 cfs diversion at Reserve Relief Canal
4) 10,000 cfs diversion at Bonnet Carre Spillway
5) 10,000 cfs diversion at White's Ditch
6) 250,000 cfs pulse at American/California Bay with sediment enrichment
7) 12,000 cfs diversion at Bayou Lamoque
8) 52,000 cfs diversion at Fort St. Philip with sediment enrichment
9) Sediment delivery via pipeline at American/California Bay
River diversion
Marsh creation
Influence area
Subprovince boundary
Subprovince 1
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-191
Map Date: May 8, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10 15
Miles
N
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 1 Alternative E3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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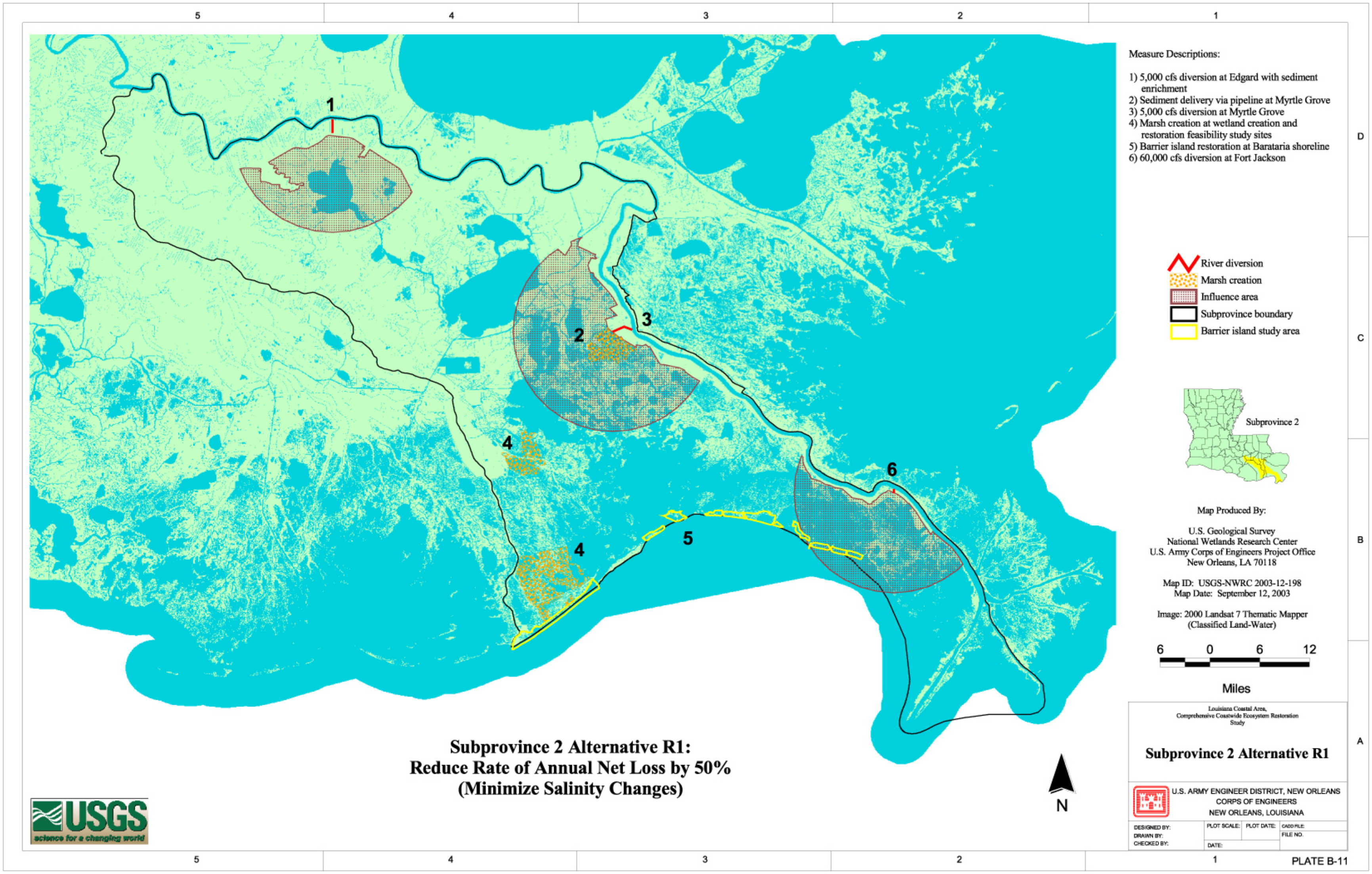
PLOT SCALE:
PLOT DATE:
CADD FILE:
FILE NO.
DATE:
PLATE B-10



Measure Descriptions:
1) 5,000 cfs diversion at Edgard with sediment enrichment
2) Sediment delivery via pipeline at Myrtle Grove
3) 5,000 cfs diversion at Myrtle Grove
4) Marsh creation at wetland creation and restoration feasibility study sites
5) Barrier island restoration at Barataria shoreline
6) 60,000 cfs diversion at Fort Jackson
River diversion
Marsh creation
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-198
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
Subprovince 2 Alternative R1:
Reduce Rate of Annual Net Loss by 50%
(Minimize Salinity Changes)
N
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 2 Alternative R1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
CADD FILE:
FILE NO.
DATE:
PLATE B-11

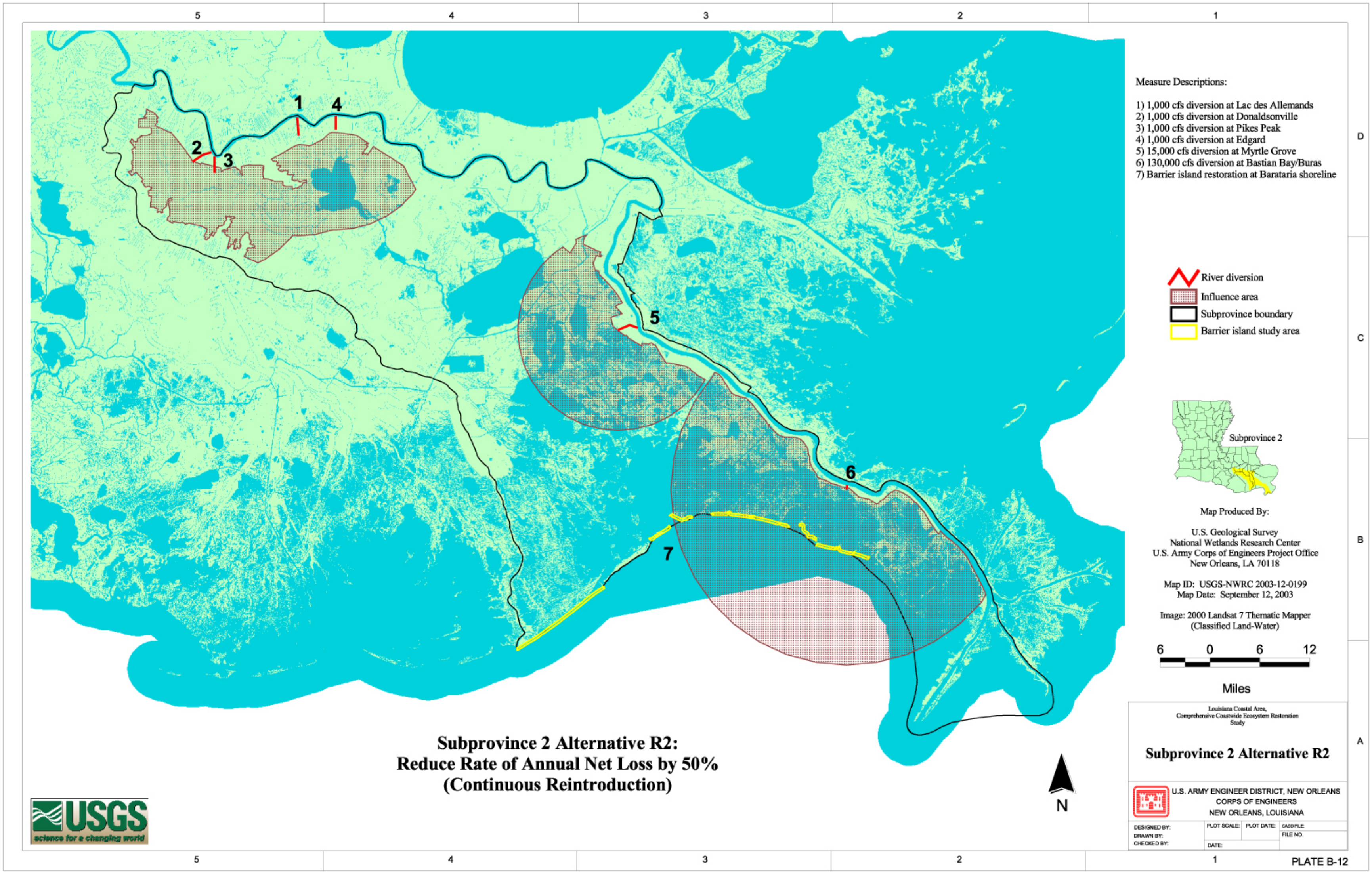
Measure Descriptions:
1) 1,000 cfs diversion at Lac des Allemands
2) 1,000 cfs diversion at Donaldsonville
3) 1,000 cfs diversion at Pikes Peak
4) 1,000 cfs diversion at Edgard
5) 15,000 cfs diversion at Myrtle Grove
6) 130,000 cfs diversion at Bastian Bay/Buras
7) Barrier island restoration at Barataria shoreline
River diversion
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0199
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
N
Subprovince 2 Alternative R2:
Reduce Rate of Annual Net Loss by 50%
(Continuous Reintroduction)
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 2 Alternative R2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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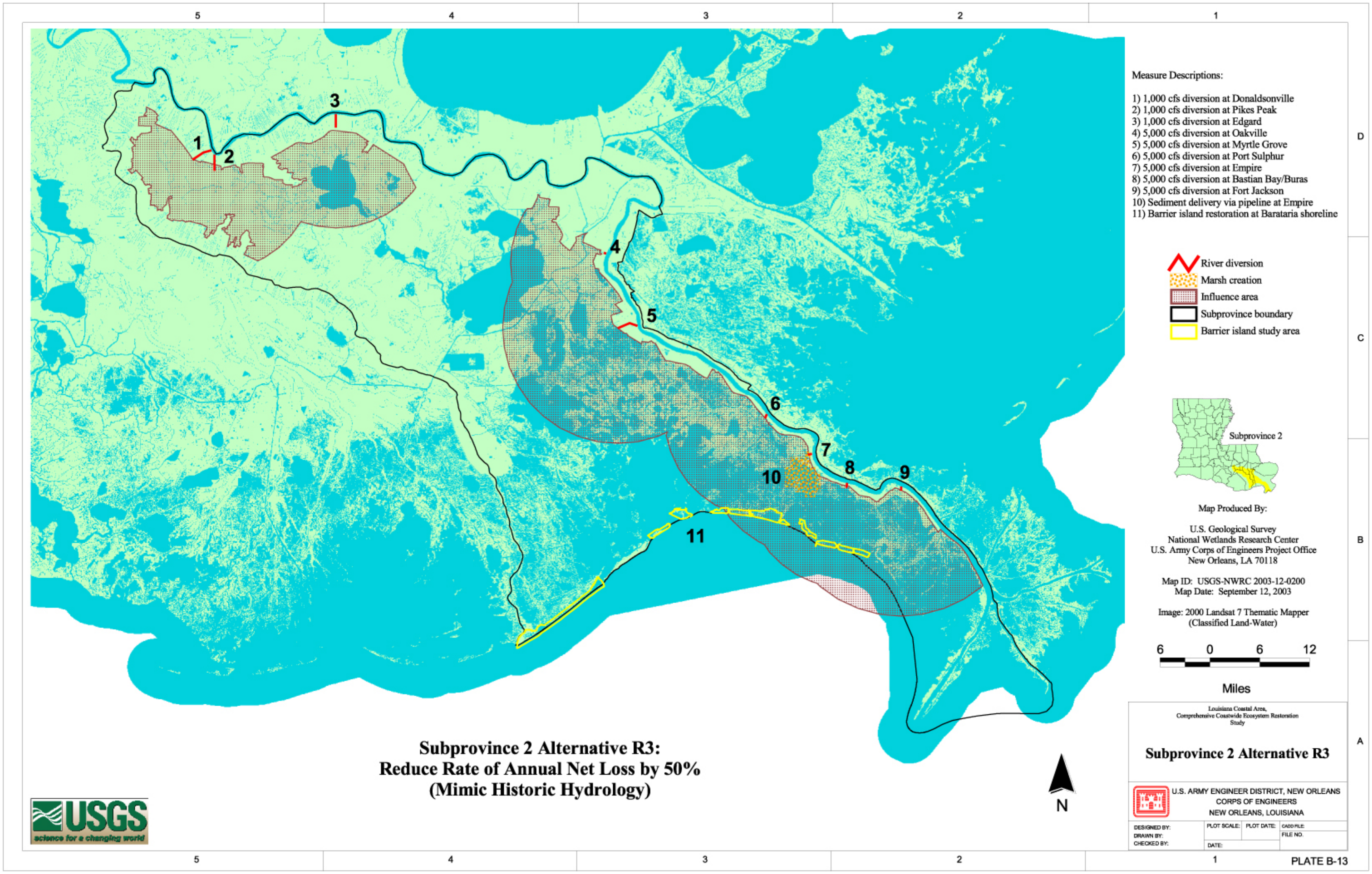
PLATE B-12



Measure Descriptions:
1) 1,000 cfs diversion at Donaldsonville
2) 1,000 cfs diversion at Pikes Peak
3) 1,000 cfs diversion at Edgard
4) 5,000 cfs diversion at Oakville
5) 5,000 cfs diversion at Myrtle Grove
6) 5,000 cfs diversion at Port Sulphur
7) 5,000 cfs diversion at Empire
8) 5,000 cfs diversion at Bastian Bay/Buras
9) 5,000 cfs diversion at Fort Jackson
10) Sediment delivery via pipeline at Empire
11) Barrier island restoration at Barataria shoreline
River diversion
Marsh creation
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0200
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
Subprovince 2 Alternative R3:
Reduce Rate of Annual Net Loss by 50%
(Mimic Historic Hydrology)
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 2 Alternative R3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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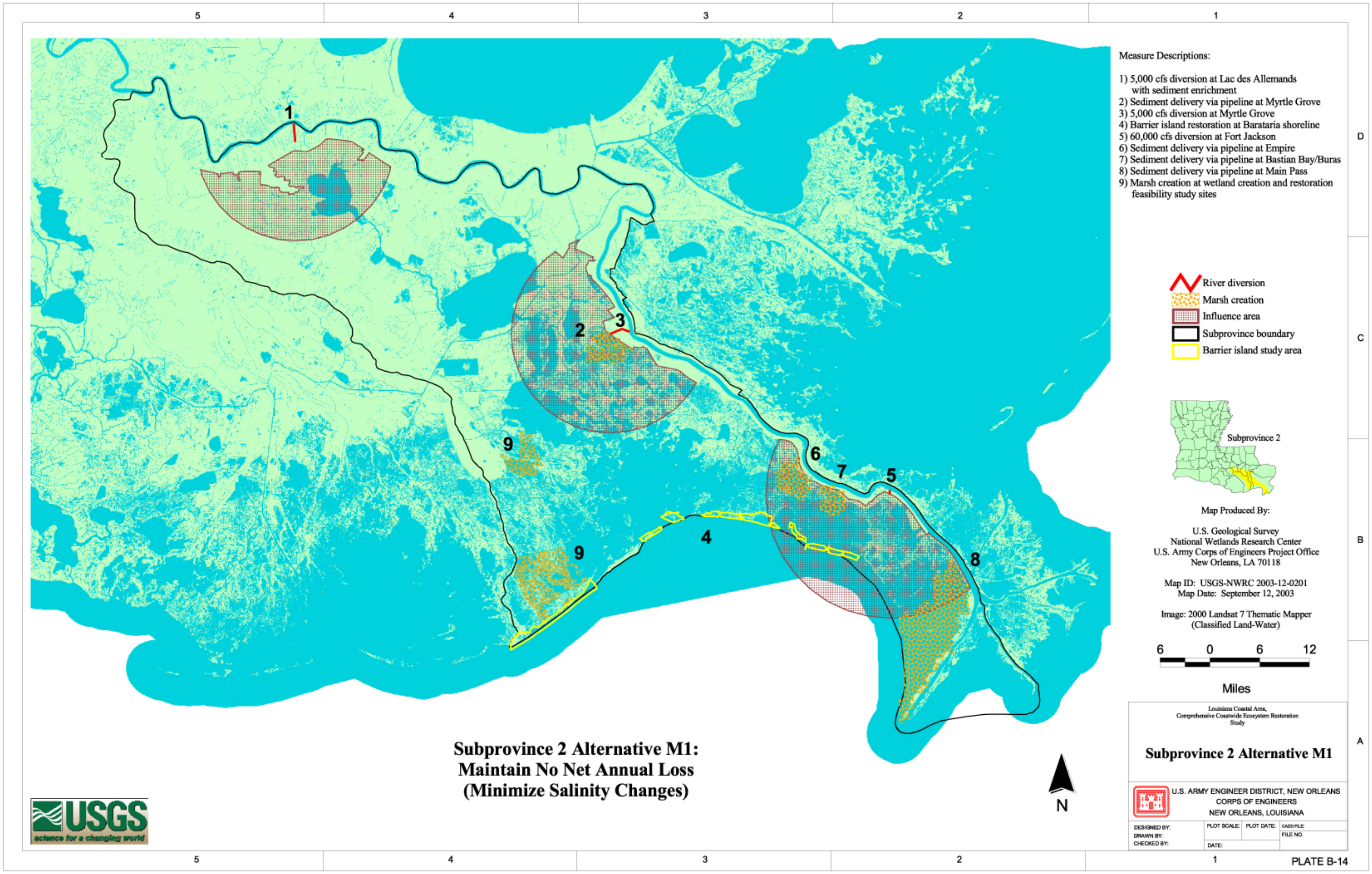
PLOT SCALE:
PLOT DATE:
DATE:
CADD FILE:
FILE NO.
PLATE B-13


Measure Descriptions:
1) 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2) Sediment delivery via pipeline at Myrtle Grove
3) 5,000 cfs diversion at Myrtle Grove
4) Barrier island restoration at Barataria shoreline
5) 60,000 cfs diversion at Fort Jackson
6) Sediment delivery via pipeline at Empire
7) Sediment delivery via pipeline at Bastian Bay/Buras
8) Sediment delivery via pipeline at Main Pass
9) Marsh creation at wetland creation and restoration feasibility study sites
River diversion
Marsh creation
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0201
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
N
Subprovince 2 Alternative M1:
Maintain No Net Annual Loss
(Minimize Salinity Changes)
USGS
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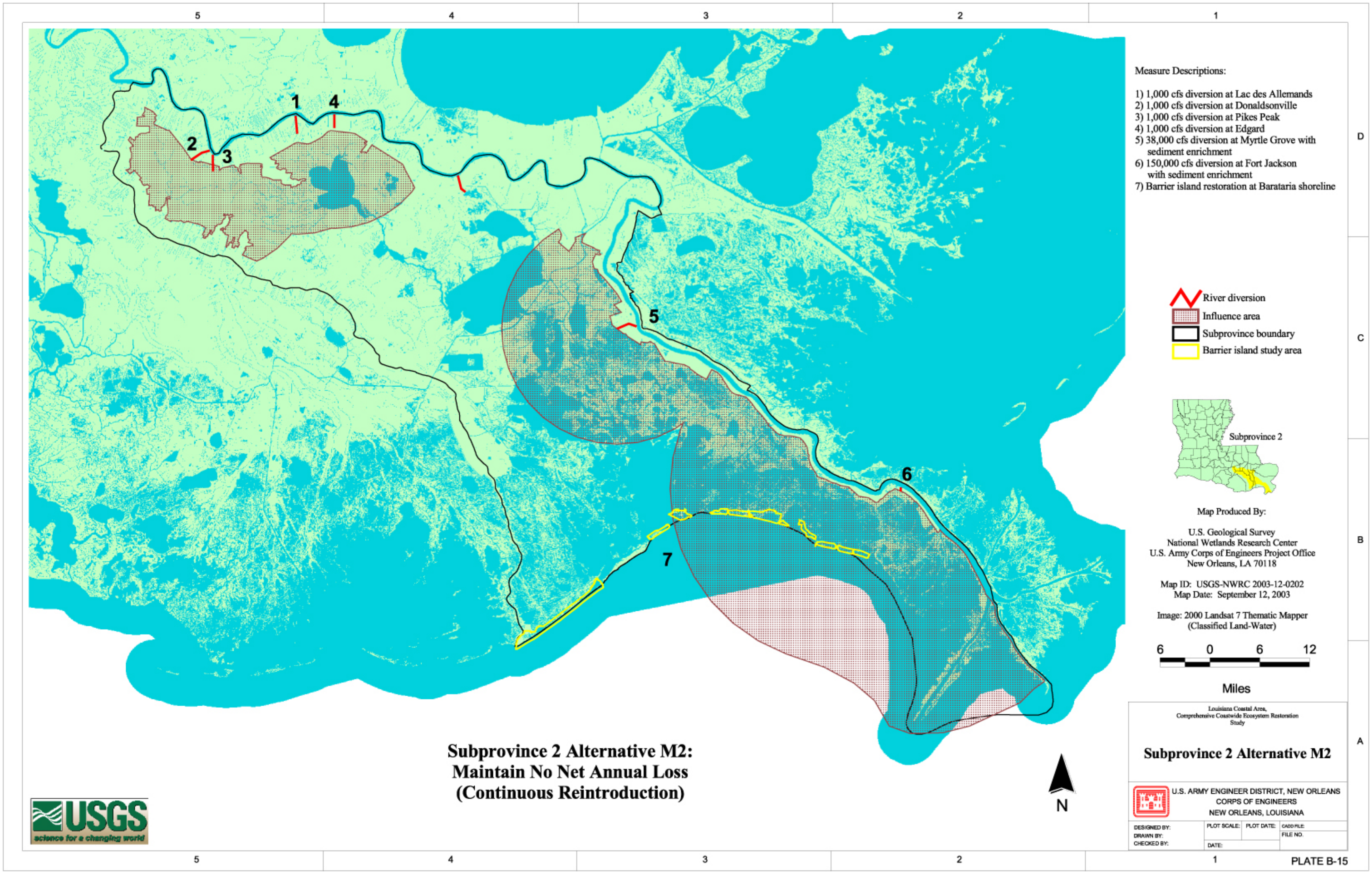
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 2 Alternative M1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
PLATE B-14



Measure Descriptions:
1) 1,000 cfs diversion at Lac des Allemands
2) 1,000 cfs diversion at Donaldsonville
3) 1,000 cfs diversion at Pikes Peak
4) 1,000 cfs diversion at Edgard
5) 38,000 cfs diversion at Myrtle Grove with sediment enrichment
6) 150,000 cfs diversion at Fort Jackson with sediment enrichment
7) Barrier island restoration at Barataria shoreline
River diversion
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0202
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
Subprovince 2 Alternative M2:
Maintain No Net Annual Loss
(Continuous Reintroduction)
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 2 Alternative M2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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PLOT SCALE:
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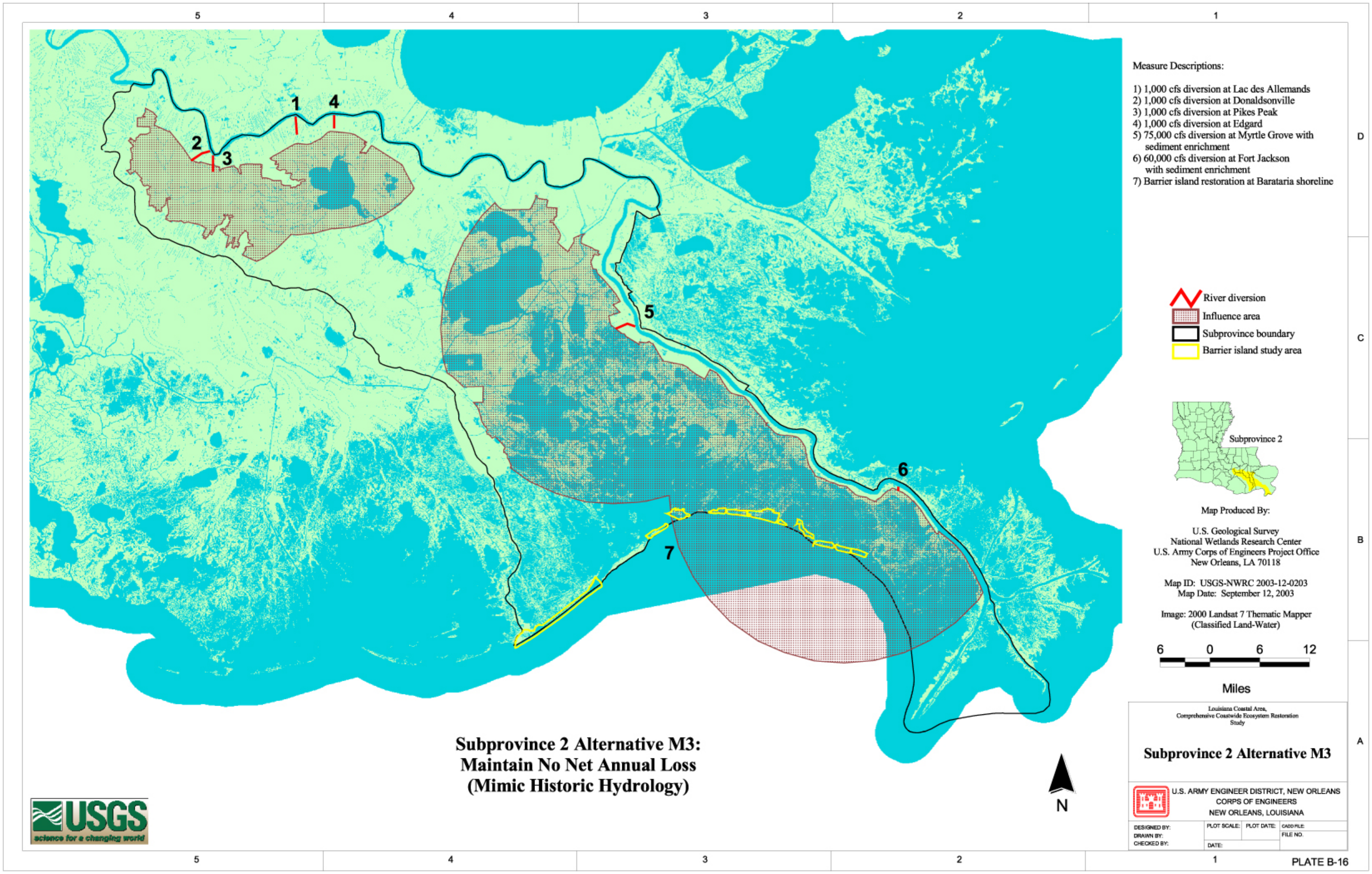
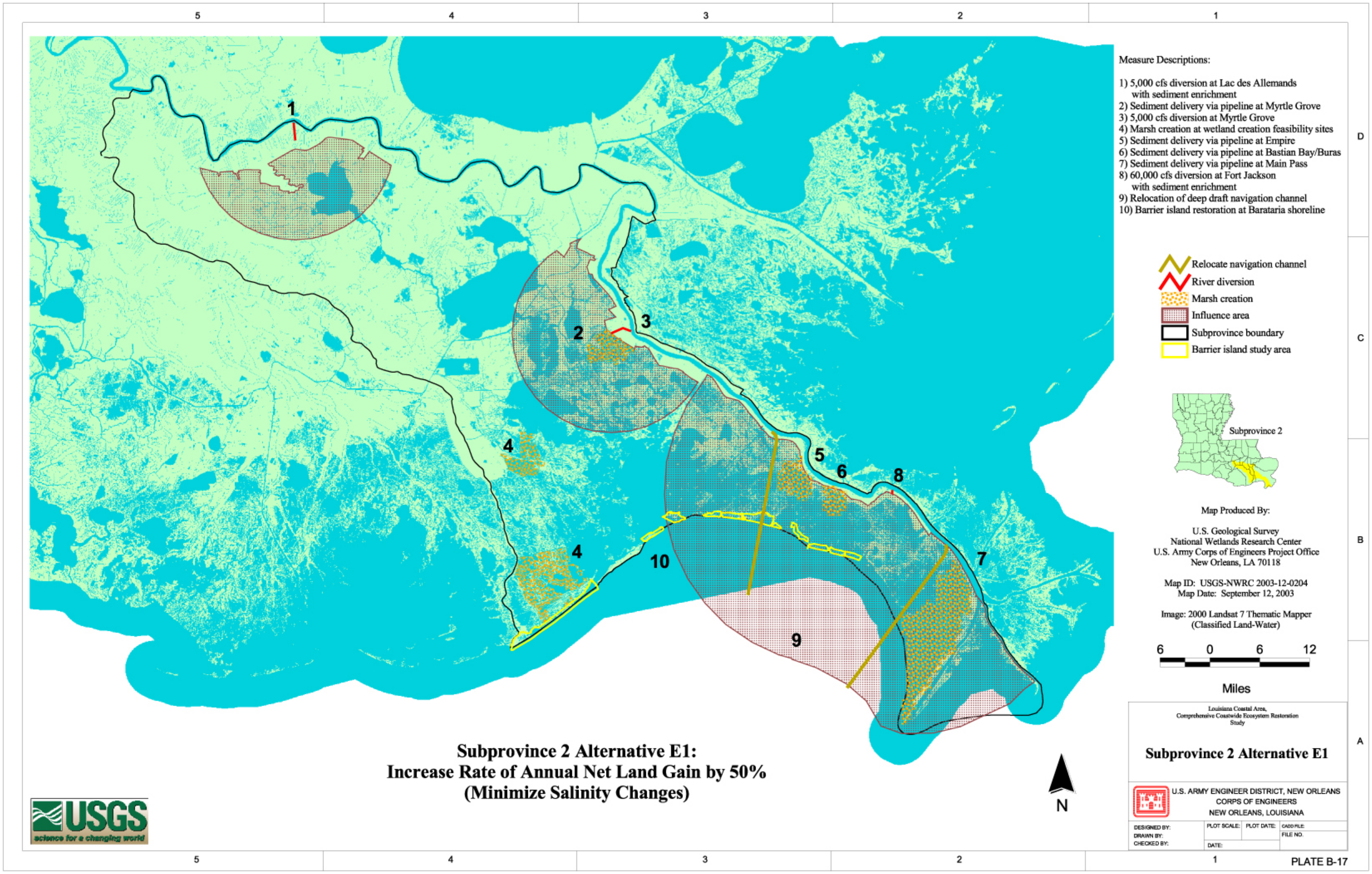
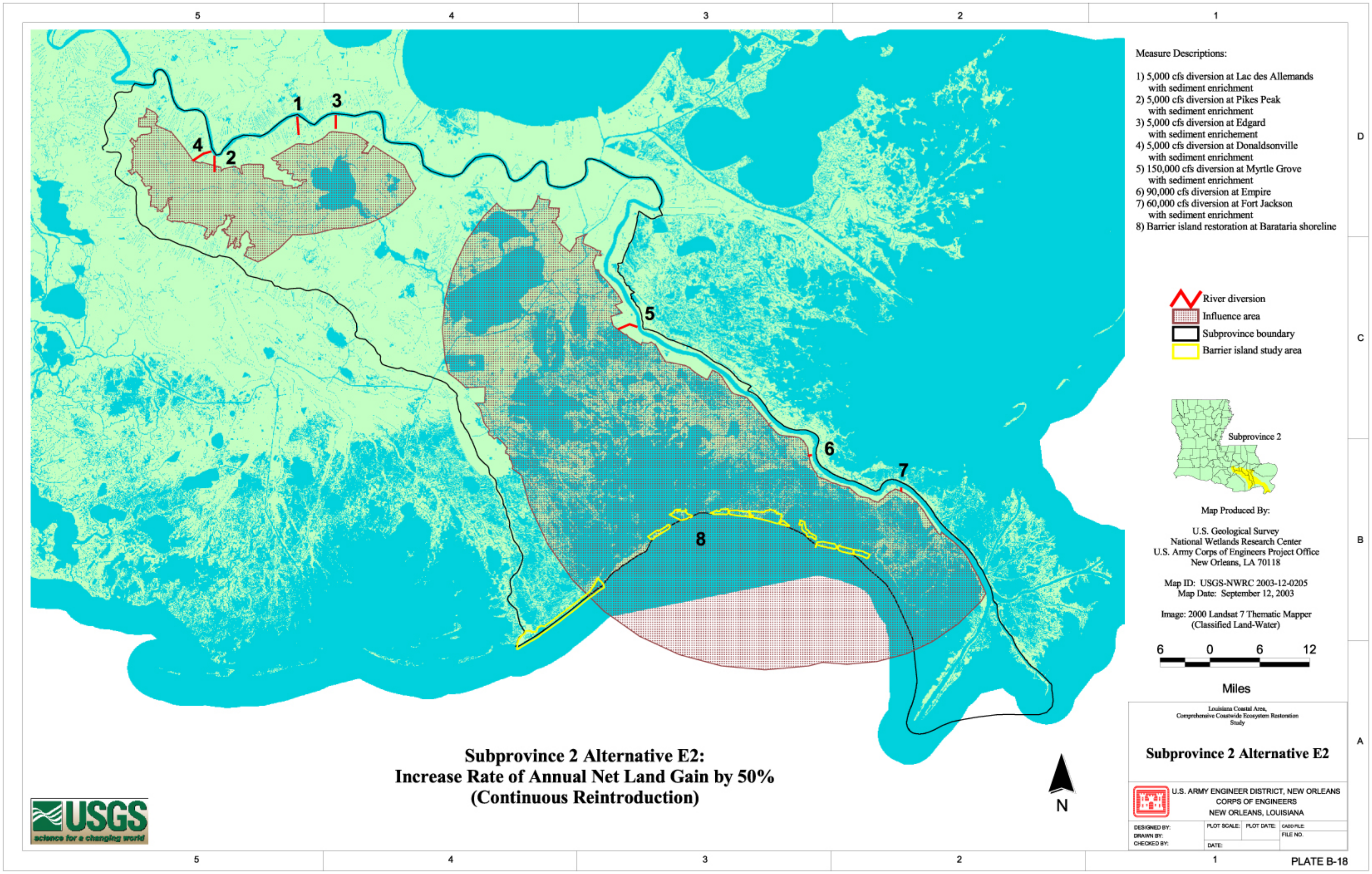
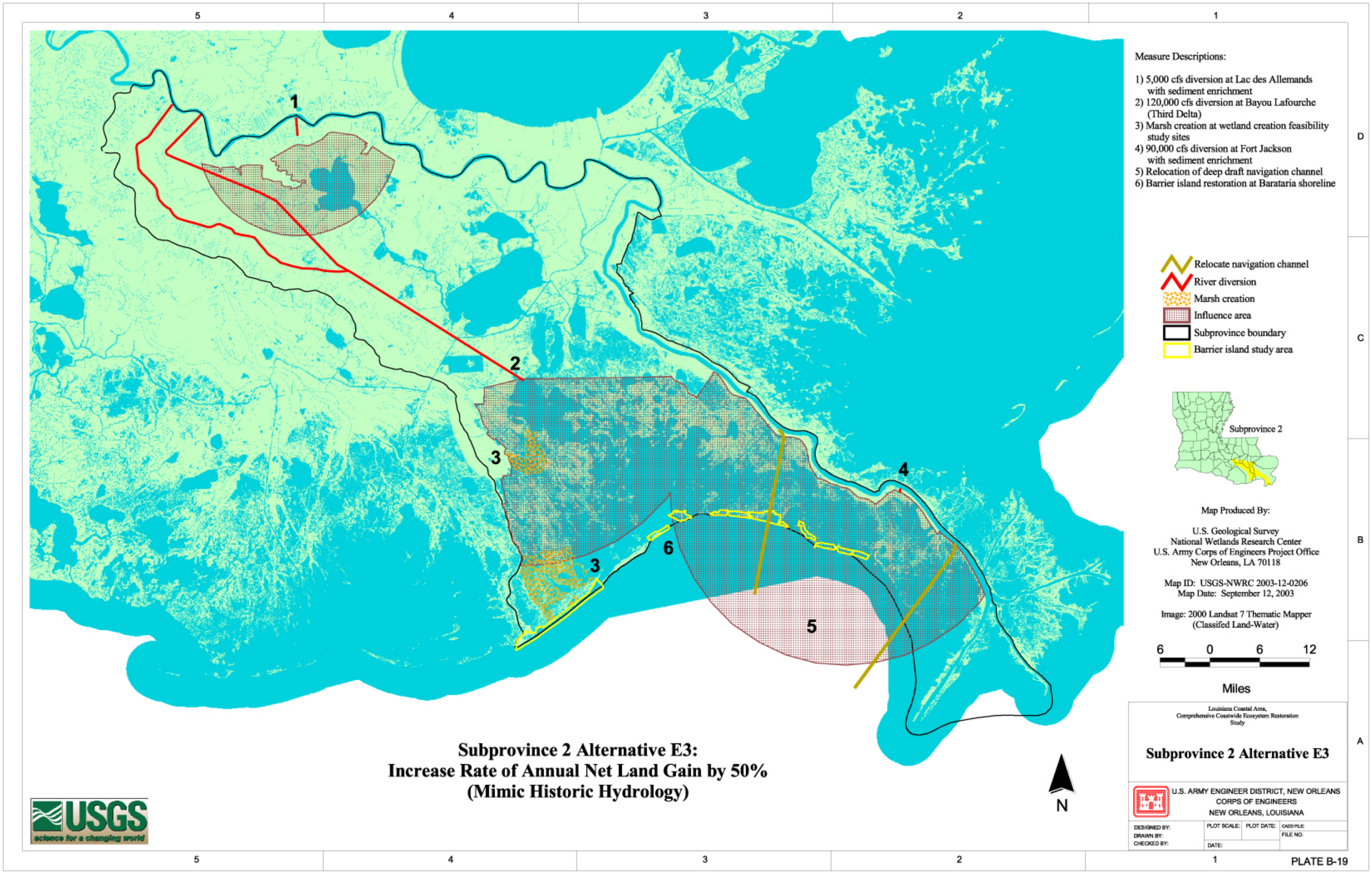
PLATE B-15



Measure Descriptions:
1) 1,000 cfs diversion at Lac des Allemands
2) 1,000 cfs diversion at Donaldsonville
3) 1,000 cfs diversion at Pikes Peak
4) 1,000 cfs diversion at Edgard
5) 75,000 cfs diversion at Myrtle Grove with sediment enrichment
6) 60,000 cfs diversion at Fort Jackson with sediment enrichment
7) Barrier island restoration at Barataria shoreline
River diversion
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0203
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
Subprovince 2 Alternative M3:
Maintain No Net Annual Loss
(Mimic Historic Hydrology)
N
Subprovince 2 Alternative M3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
PLATE B-16


Measure Descriptions:
1) 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2) Sediment delivery via pipeline at Myrtle Grove
3) 5,000 cfs diversion at Myrtle Grove
4) Marsh creation at wetland creation feasibility sites
5) Sediment delivery via pipeline at Empire
6) Sediment delivery via pipeline at Bastian Bay/Buras
7) Sediment delivery via pipeline at Main Pass
8) 60,000 cfs diversion at Fort Jackson with sediment enrichment
9) Relocation of deep draft navigation channel
10) Barrier island restoration at Barataria shoreline
Relocate navigation channel
River diversion
Marsh creation
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0204
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
N
Subprovince 2 Alternative E1:
Increase Rate of Annual Net Land Gain by 50%
(Minimize Salinity Changes)
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 2 Alternative E1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
DATE:
CADD FILE:
FILE NO.
PLATE B-17


Measure Descriptions:
1) 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2) 5,000 cfs diversion at Pikes Peak with sediment enrichment
3) 5,000 cfs diversion at Edgard with sediment enrichment
4) 5,000 cfs diversion at Donaldsonville with sediment enrichment
5) 150,000 cfs diversion at Myrtle Grove with sediment enrichment
6) 90,000 cfs diversion at Empire
7) 60,000 cfs diversion at Fort Jackson with sediment enrichment
8) Barrier island restoration at Barataria shoreline
River diversion
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0205
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 2 Alternative E2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
Subprovince 2 Alternative E2:
Increase Rate of Annual Net Land Gain by 50%
(Continuous Reintroduction)
N
USGS
science for a changing world
PLATE B-18


Measure Descriptions:
1) 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2) 120,000 cfs diversion at Bayou Lafourche (Third Delta)
3) Marsh creation at wetland creation feasibility study sites
4) 90,000 cfs diversion at Fort Jackson with sediment enrichment
5) Relocation of deep draft navigation channel
6) Barrier island restoration at Barataria shoreline
Relocate navigation channel
River diversion
Marsh creation
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0206
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper (Classified Land-Water)
6 0 6 12
Miles
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 2 Alternative E3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
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CHECKED BY:
PLOT SCALE:
PLOT DATE:
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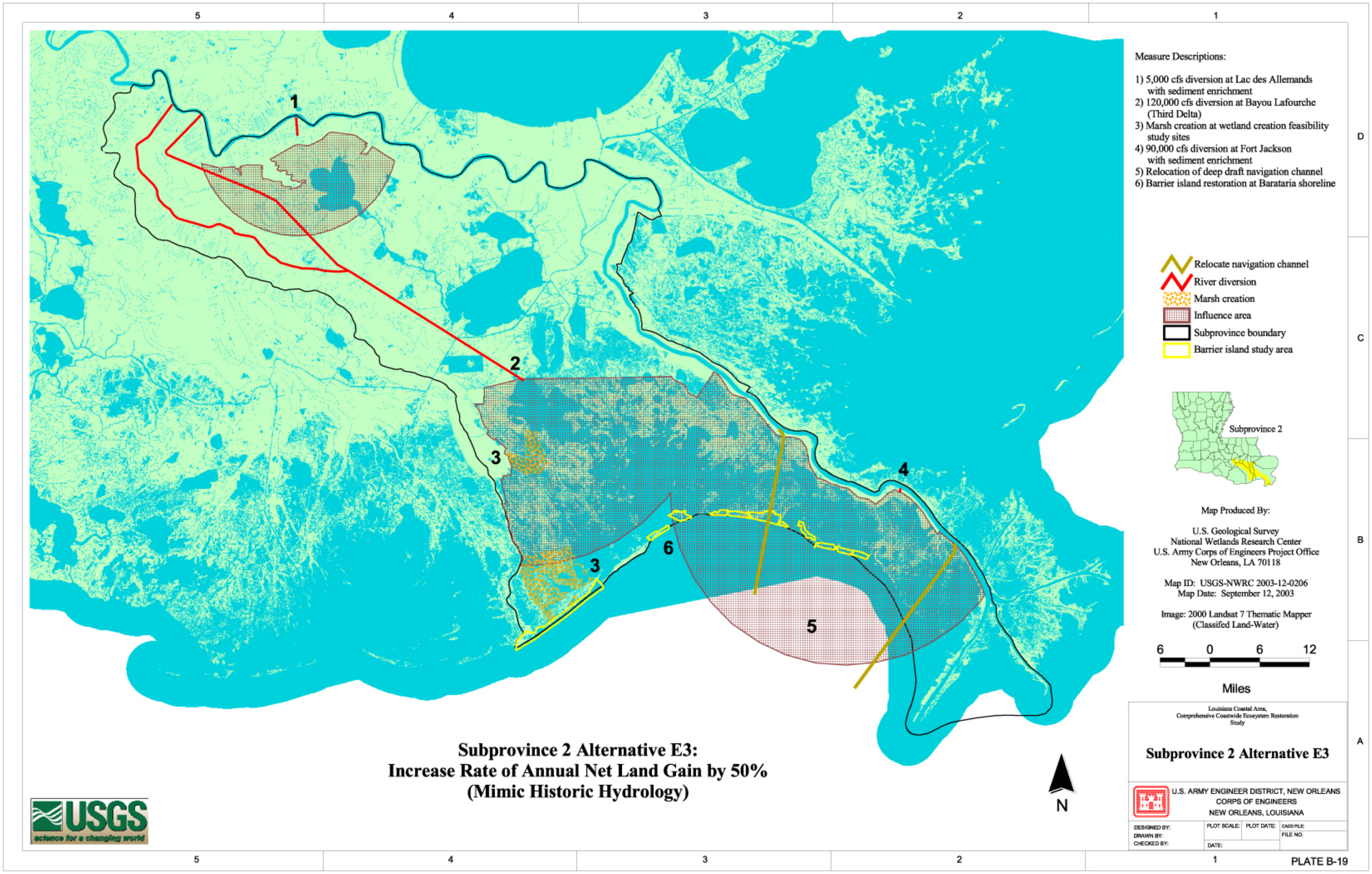
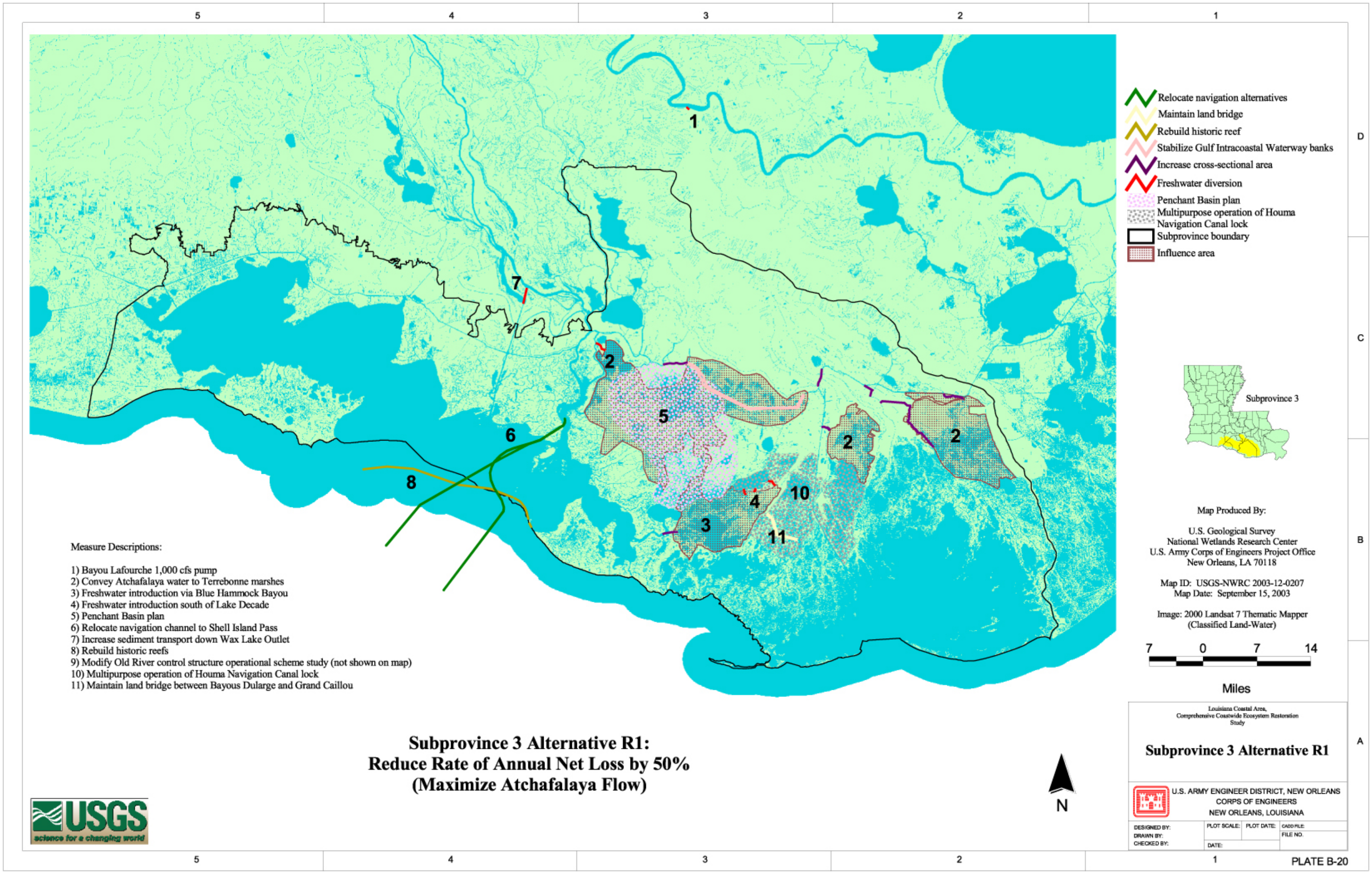
CADD FILE:
FILE NO.
PLATE B-19
Subprovince 2 Alternative E3:
Increase Rate of Annual Net Land Gain by 50%
(Mimic Historic Hydrology)
N
USGS
science for a changing world


Measure Descriptions:
1) 5,000 cfs diversion at Lac des Allemands with sediment enrichment
2) 120,000 cfs diversion at Bayou Lafourche (Third Delta)
3) Marsh creation at wetland creation feasibility study sites
4) 90,000 cfs diversion at Fort Jackson with sediment enrichment
5) Relocation of deep draft navigation channel
6) Barrier island restoration at Barataria shoreline
Relocate navigation channel
River diversion
Marsh creation
Influence area
Subprovince boundary
Barrier island study area
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0206
Map Date: September 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
6 0 6 12
Miles
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 2 Alternative E3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
DATE:
CADD FILE:
FILE NO.
PLATE B-19
Subprovince 2 Alternative E3:
Increase Rate of Annual Net Land Gain by 50%
(Mimic Historic Hydrology)
USGS
science for a changing world
N


Relocate navigation alternatives
Maintain land bridge
Rebuild historic reef
Stabilize Gulf Intracoastal Waterway banks
Increase cross-sectional area
Freshwater diversion
Penchant Basin plan
Multipurpose operation of Houma Navigation Canal lock
Subprovince boundary
Influence area
Subprovince 3
Measure Descriptions:
1) Bayou Lafourche 1,000 cfs pump
2) Convey Atchafalaya water to Terrebonne marshes
3) Freshwater introduction via Blue Hammock Bayou
4) Freshwater introduction south of Lake Decade
5) Penchant Basin plan
6) Relocate navigation channel to Shell Island Pass
7) Increase sediment transport down Wax Lake Outlet
8) Rebuild historic reefs
9) Modify Old River control structure operational scheme study (not shown on map)
10) Multipurpose operation of Houma Navigation Canal lock
11) Maintain land bridge between Bayous Dularge and Grand Caillou
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0207
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
7 0 7 14
Miles
N
Subprovince 3 Alternative R1:
Reduce Rate of Annual Net Loss by 50%
(Maximize Atchafalaya Flow)
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 3 Alternative R1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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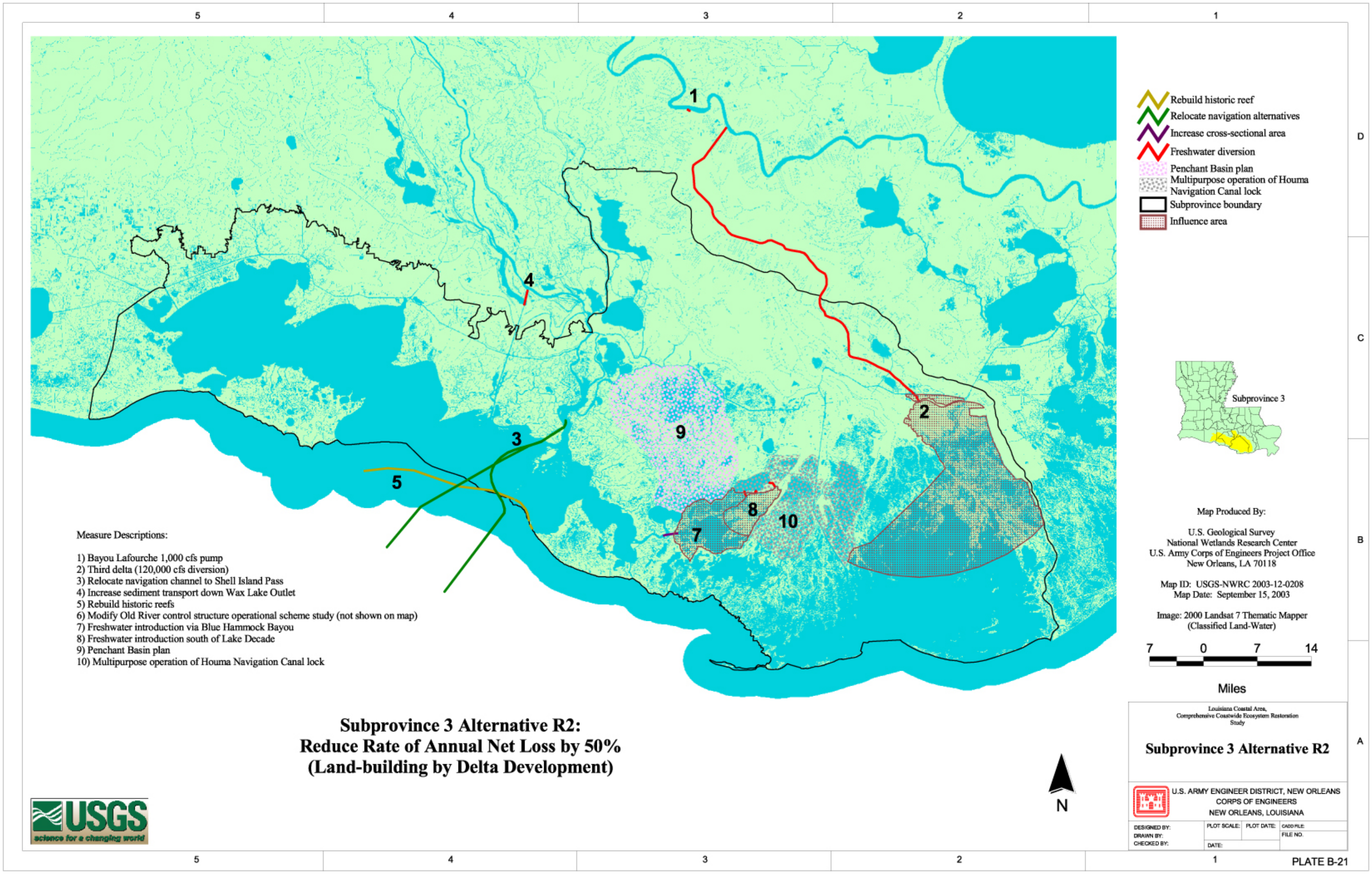
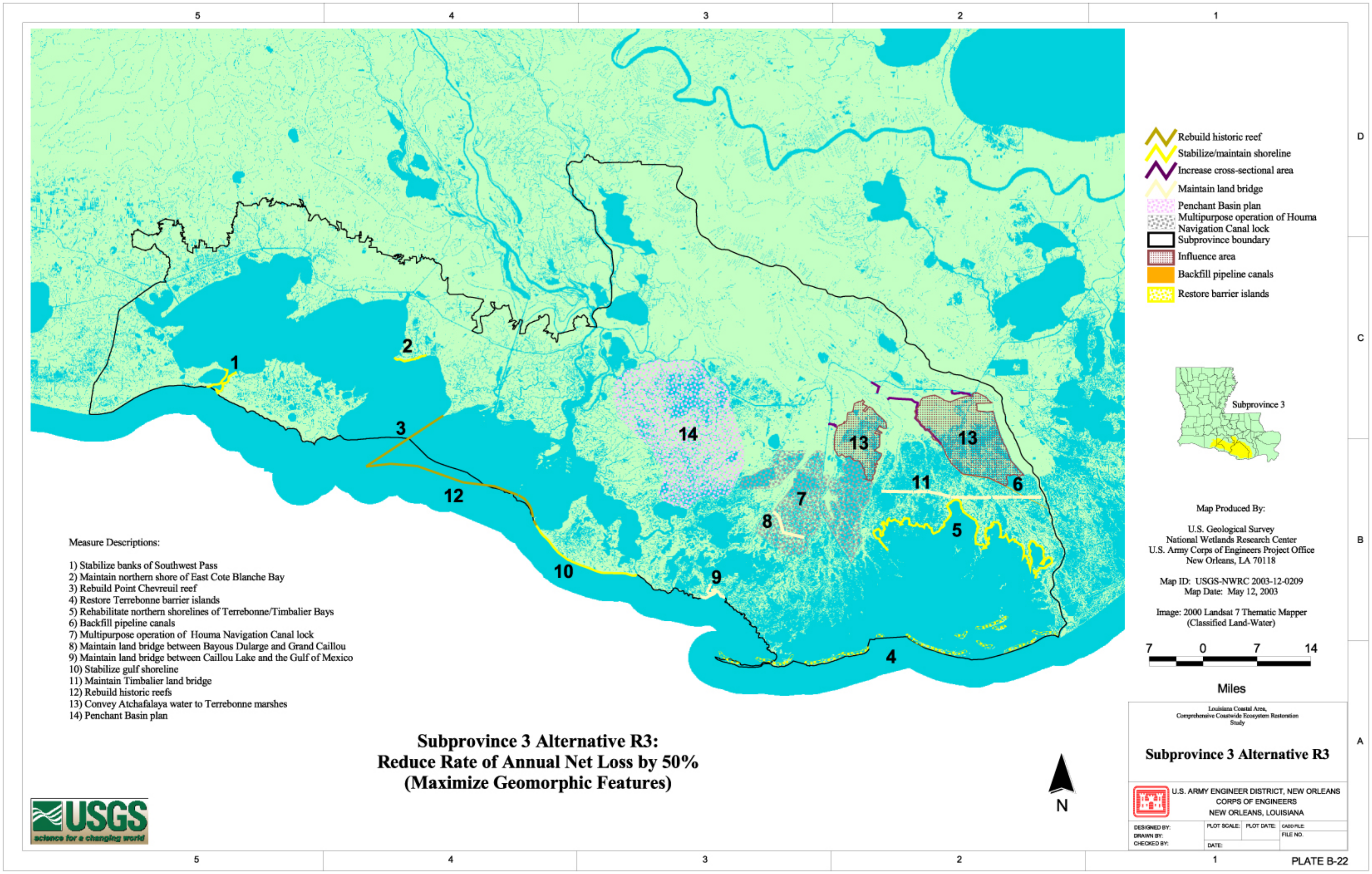
PLOT SCALE:
PLOT DATE:
DATE:
CADD FILE:
FILE NO.
PLATE B-20



Rebuild historic reef
Relocate navigation alternatives
Increase cross-sectional area
Freshwater diversion
Penchant Basin plan
Multipurpose operation of Houma Navigation Canal lock
Subprovince boundary
Influence area
Subprovince 3
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0208
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
7 0 7 14
Miles
N
Measure Descriptions:
1) Bayou Lafourche 1,000 cfs pump
2) Third delta (120,000 cfs diversion)
3) Relocate navigation channel to Shell Island Pass
4) Increase sediment transport down Wax Lake Outlet
5) Rebuild historic reefs
6) Modify Old River control structure operational scheme study (not shown on map)
7) Freshwater introduction via Blue Hammock Bayou
8) Freshwater introduction south of Lake Decade
9) Penchant Basin plan
10) Multipurpose operation of Houma Navigation Canal lock
Subprovince 3 Alternative R2:
Reduce Rate of Annual Net Loss by 50%
(Land-building by Delta Development)
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 3 Alternative R2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
PLATE B-21


Rebuild historic reef
Stabilize/maintain shoreline
Increase cross-sectional area
Maintain land bridge
Penchant Basin plan
Multipurpose operation of Houma Navigation Canal lock
Subprovince boundary
Influence area
Backfill pipeline canals
Restore barrier islands
Subprovince 3
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0209
Map Date: May 12, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
7 0 7 14
Miles
Measure Descriptions:
1) Stabilize banks of Southwest Pass
2) Maintain northern shore of East Cote Blanche Bay
3) Rebuild Point Chevreuil reef
4) Restore Terrebonne barrier islands
5) Rehabilitate northern shorelines of Terrebonne/Timbalier Bays
6) Backfill pipeline canals
7) Multipurpose operation of Houma Navigation Canal lock
8) Maintain land bridge between Bayous Dularge and Grand Caillou
9) Maintain land bridge between Caillou Lake and the Gulf of Mexico
10) Stabilize gulf shoreline
11) Maintain Timbalier land bridge
12) Rebuild historic reefs
13) Convey Atchafalaya water to Terrebonne marshes
14) Penchant Basin plan
Subprovince 3 Alternative R3:
Reduce Rate of Annual Net Loss by 50%
(Maximize Geomorphic Features)
USGS
science for a changing world
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 3 Alternative R3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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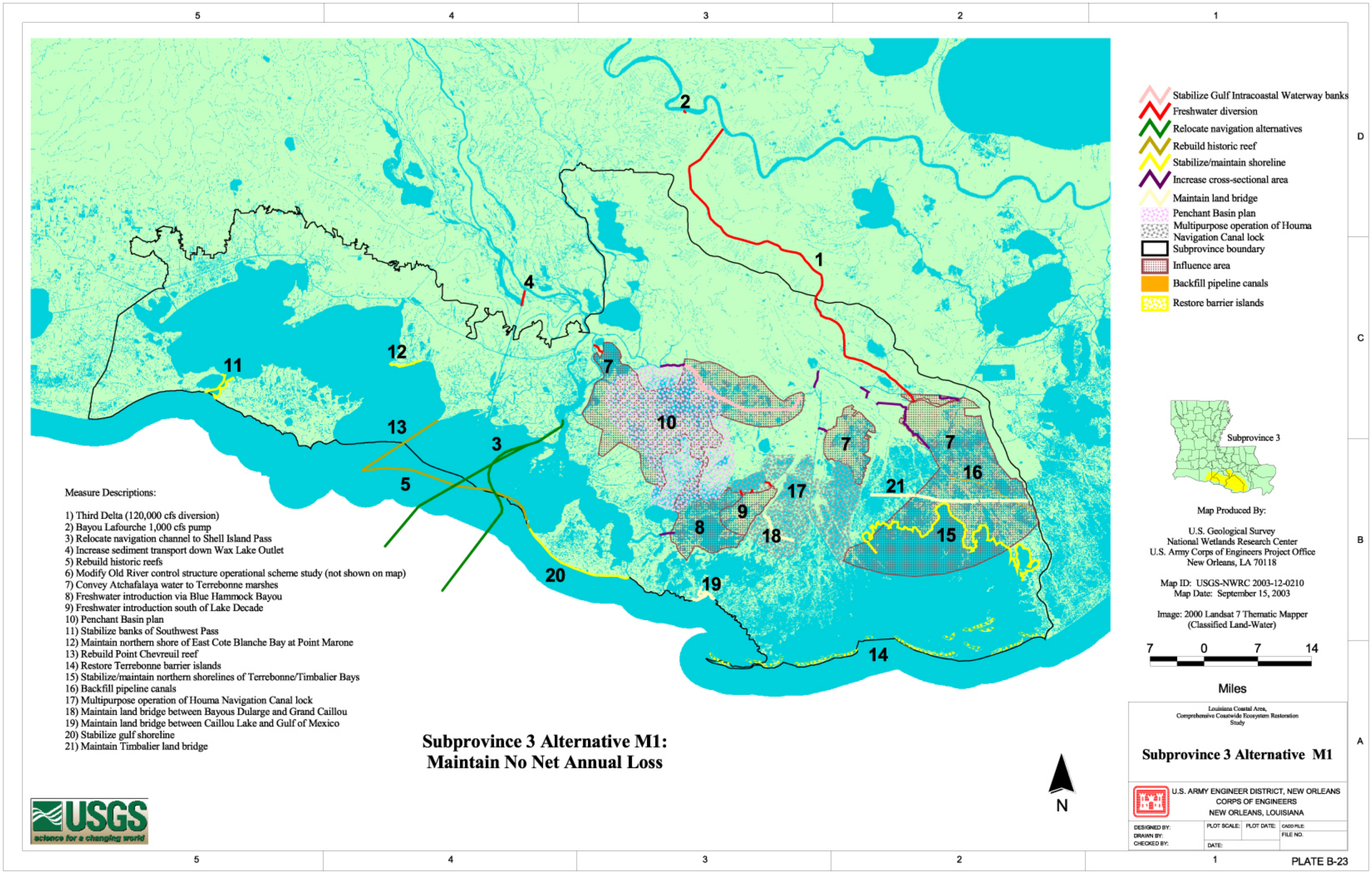
PLOT DATE:
DATE:
FILE NO.
PLATE B-22



Stabilize Gulf Intracoastal Waterway banks
Freshwater diversion
Relocate navigation alternatives
Rebuild historic reef
Stabilize/maintain shoreline
Increase cross-sectional area
Maintain land bridge
Penchant Basin plan
Multipurpose operation of Houma Navigation Canal lock
Subprovince boundary
Influence area
Backfill pipeline canals
Restore barrier islands
Subprovince 3
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0210
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
7 0 7 14
Miles
Measure Descriptions:
1) Third Delta (120,000 cfs diversion)
2) Bayou Lafourche 1,000 cfs pump
3) Relocate navigation channel to Shell Island Pass
4) Increase sediment transport down Wax Lake Outlet
5) Rebuild historic reefs
6) Modify Old River control structure operational scheme study (not shown on map)
7) Convey Atchafalaya water to Terrebonne marshes
8) Freshwater introduction via Blue Hammock Bayou
9) Freshwater introduction south of Lake Decade
10) Penchant Basin plan
11) Stabilize banks of Southwest Pass
12) Maintain northern shore of East Cote Blanche Bay at Point Marone
13) Rebuild Point Chevreuil reef
14) Restore Terrebonne barrier islands
15) Stabilize/maintain northern shorelines of Terrebonne/Timbalier Bays
16) Backfill pipeline canals
17) Multipurpose operation of Houma Navigation Canal lock
18) Maintain land bridge between Bayous Dularge and Grand Caillou
19) Maintain land bridge between Caillou Lake and Gulf of Mexico
20) Stabilize gulf shoreline
21) Maintain Timbalier land bridge
Subprovince 3 Alternative M1:
Maintain No Net Annual Loss
N
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 3 Alternative M1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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DATE:
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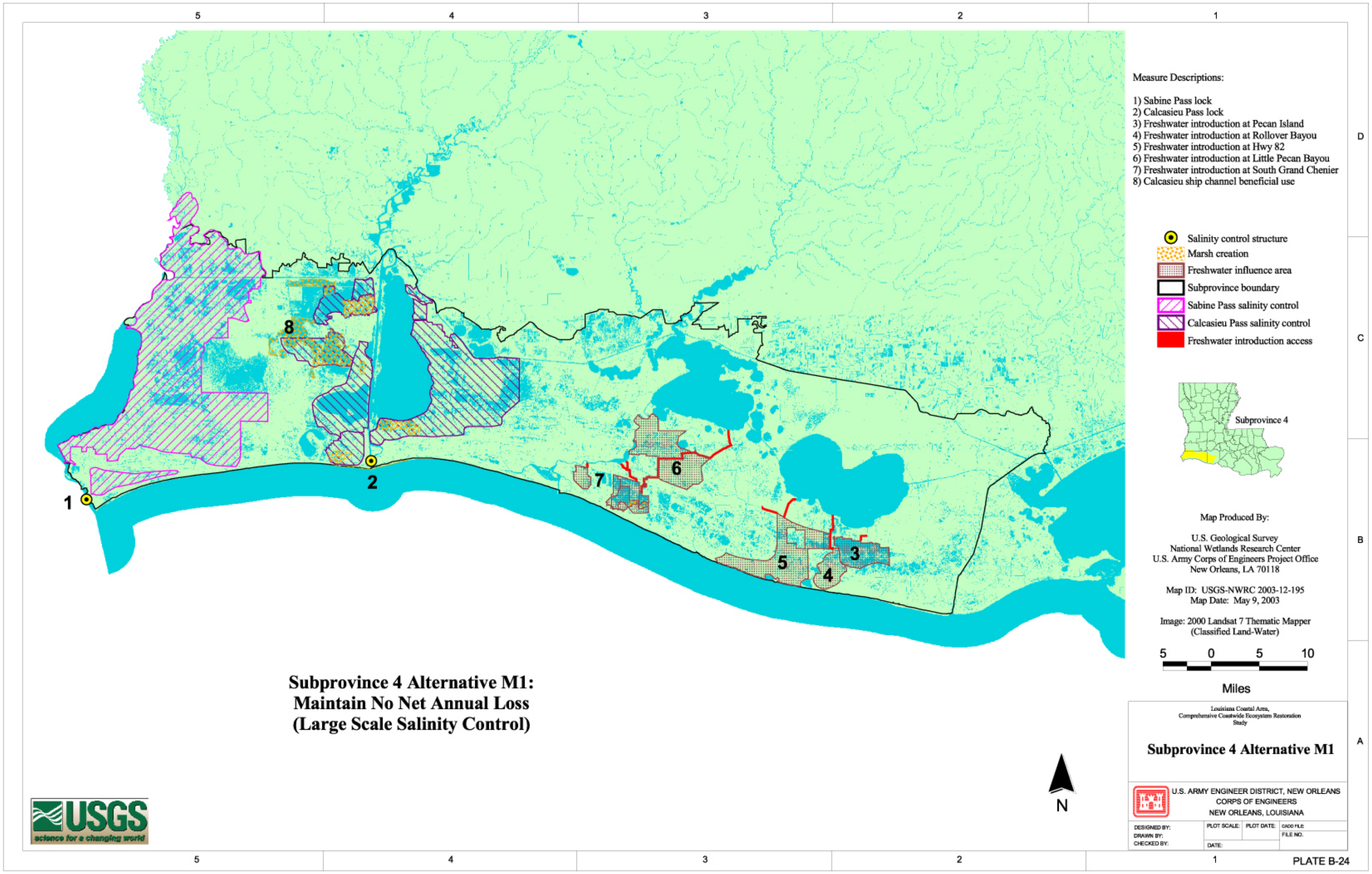
FILE NO.
PLATE B-23



Measure Descriptions:
1) Sabine Pass lock
2) Calcasieu Pass lock
3) Freshwater introduction at Pecan Island
4) Freshwater introduction at Rollover Bayou
5) Freshwater introduction at Hwy 82
6) Freshwater introduction at Little Pecan Bayou
7) Freshwater introduction at South Grand Chenier
8) Calcasieu ship channel beneficial use
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine Pass salinity control
Calcasieu Pass salinity control
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-195
Map Date: May 9, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10
Miles
Subprovince 4 Alternative M1:
Maintain No Net Annual Loss
(Large Scale Salinity Control)
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 4 Alternative M1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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PLOT SCALE:
PLOT DATE:
DATE:
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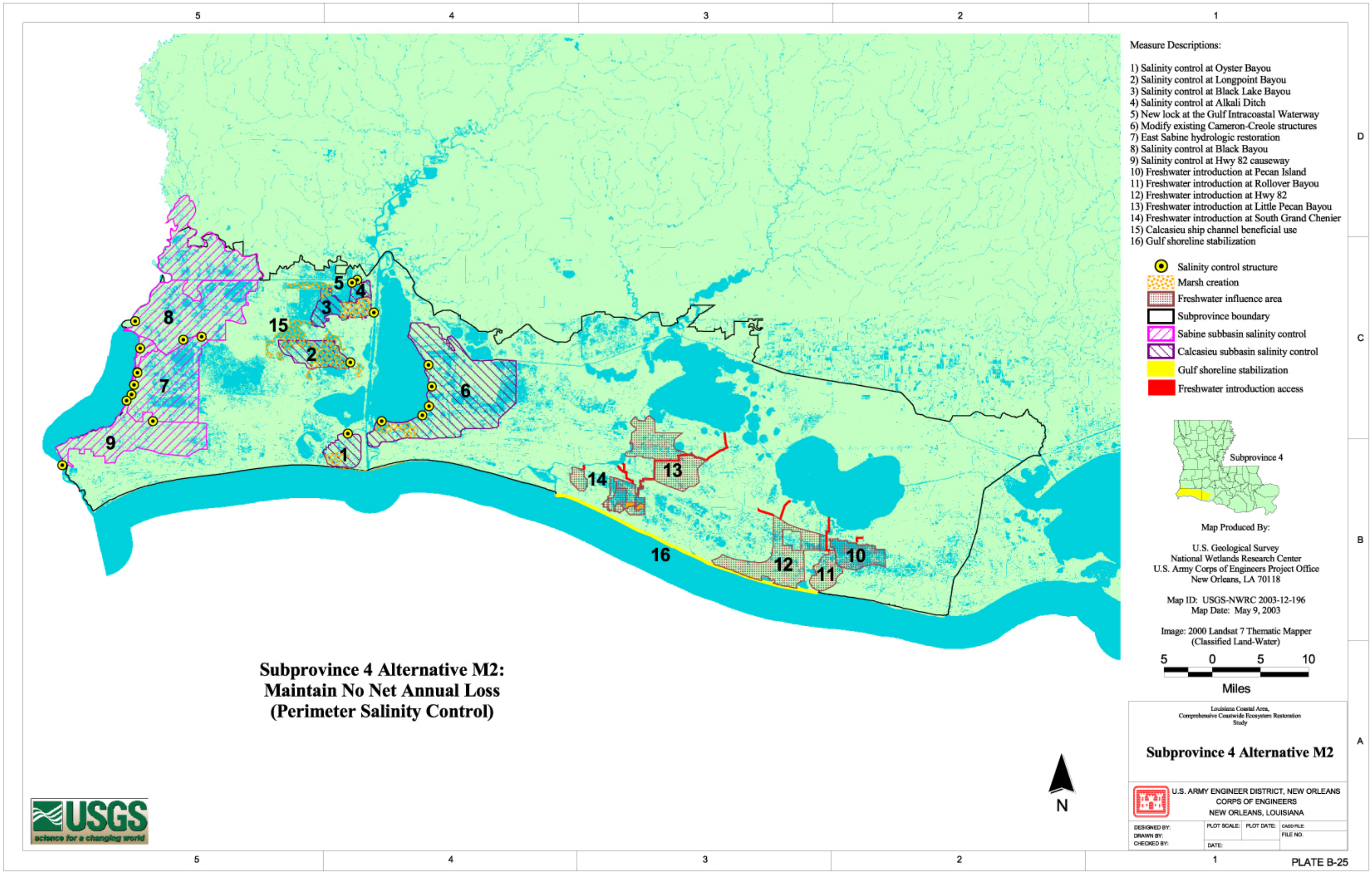
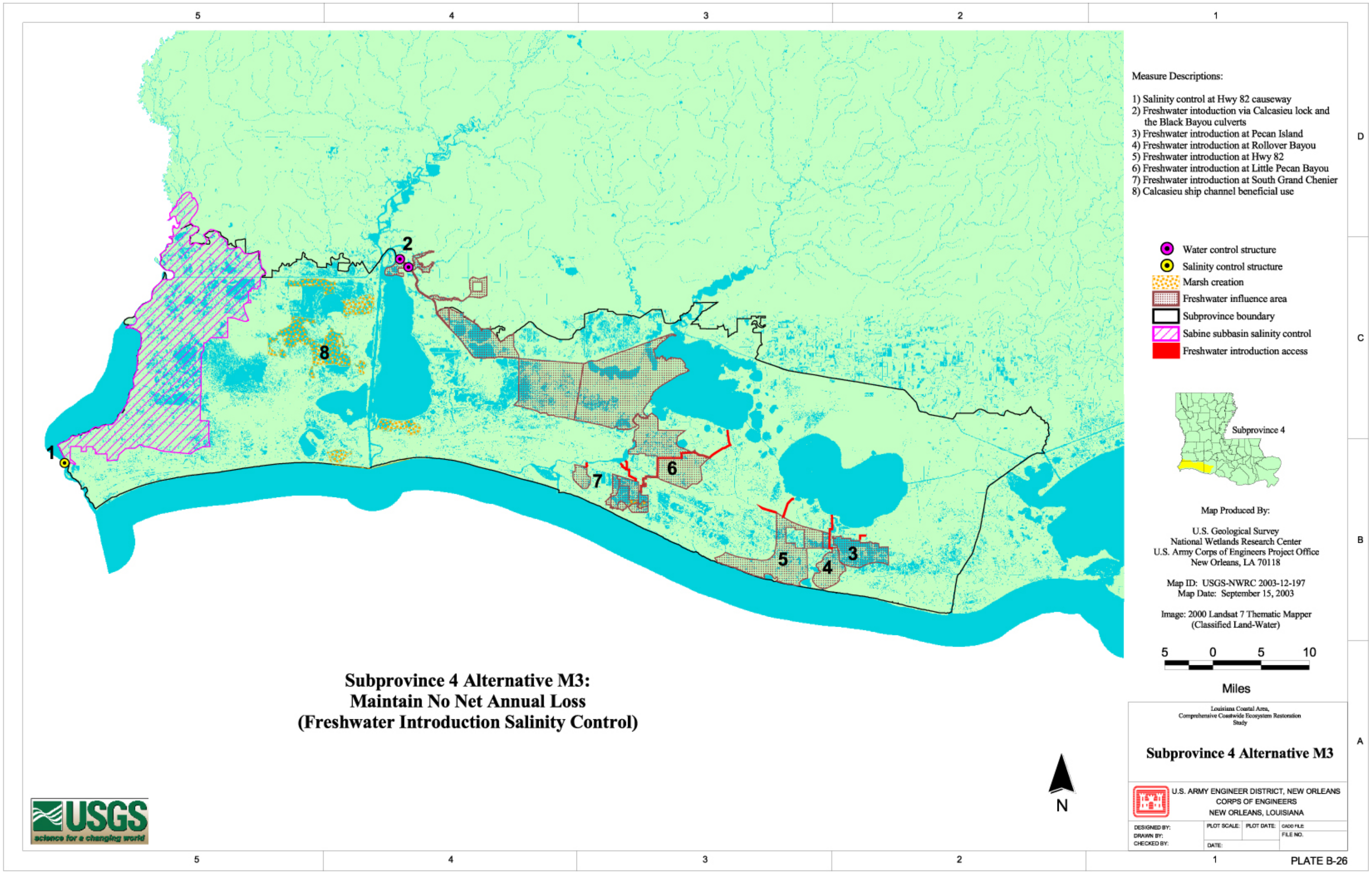
FILE NO.
PLATE B-24



Measure Descriptions:
1) Salinity control at Oyster Bayou
2) Salinity control at Longpoint Bayou
3) Salinity control at Black Lake Bayou
4) Salinity control at Alkali Ditch
5) New lock at the Gulf Intracoastal Waterway
6) Modify existing Cameron-Creole structures
7) East Sabine hydrologic restoration
8) Salinity control at Black Bayou
9) Salinity control at Hwy 82 causeway
10) Freshwater introduction at Pecan Island
11) Freshwater introduction at Rollover Bayou
12) Freshwater introduction at Hwy 82
13) Freshwater introduction at Little Pecan Bayou
14) Freshwater introduction at South Grand Chenier
15) Calcasieu ship channel beneficial use
16) Gulf shoreline stabilization
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine subbasin salinity control
Calcasieu subbasin salinity control
Gulf shoreline stabilization
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-196
Map Date: May 9, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10
Miles
Subprovince 4 Alternative M2:
Maintain No Net Annual Loss
(Perimeter Salinity Control)
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 4 Alternative M2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
PLATE B-25
N
USGS



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Measure Descriptions:
1) Salinity control at Hwy 82 causeway
2) Freshwater introduction via Calcasieu lock and the Black Bayou culverts
3) Freshwater introduction at Pecan Island
4) Freshwater introduction at Rollover Bayou
5) Freshwater introduction at Hwy 82
6) Freshwater introduction at Little Pecan Bayou
7) Freshwater introduction at South Grand Chenier
8) Calcasieu ship channel beneficial use
Water control structure
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine subbasin salinity control
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-197
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10
Miles
Subprovince 4 Alternative M3:
Maintain No Net Annual Loss
(Freshwater Introduction Salinity Control)
N
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 4 Alternative M3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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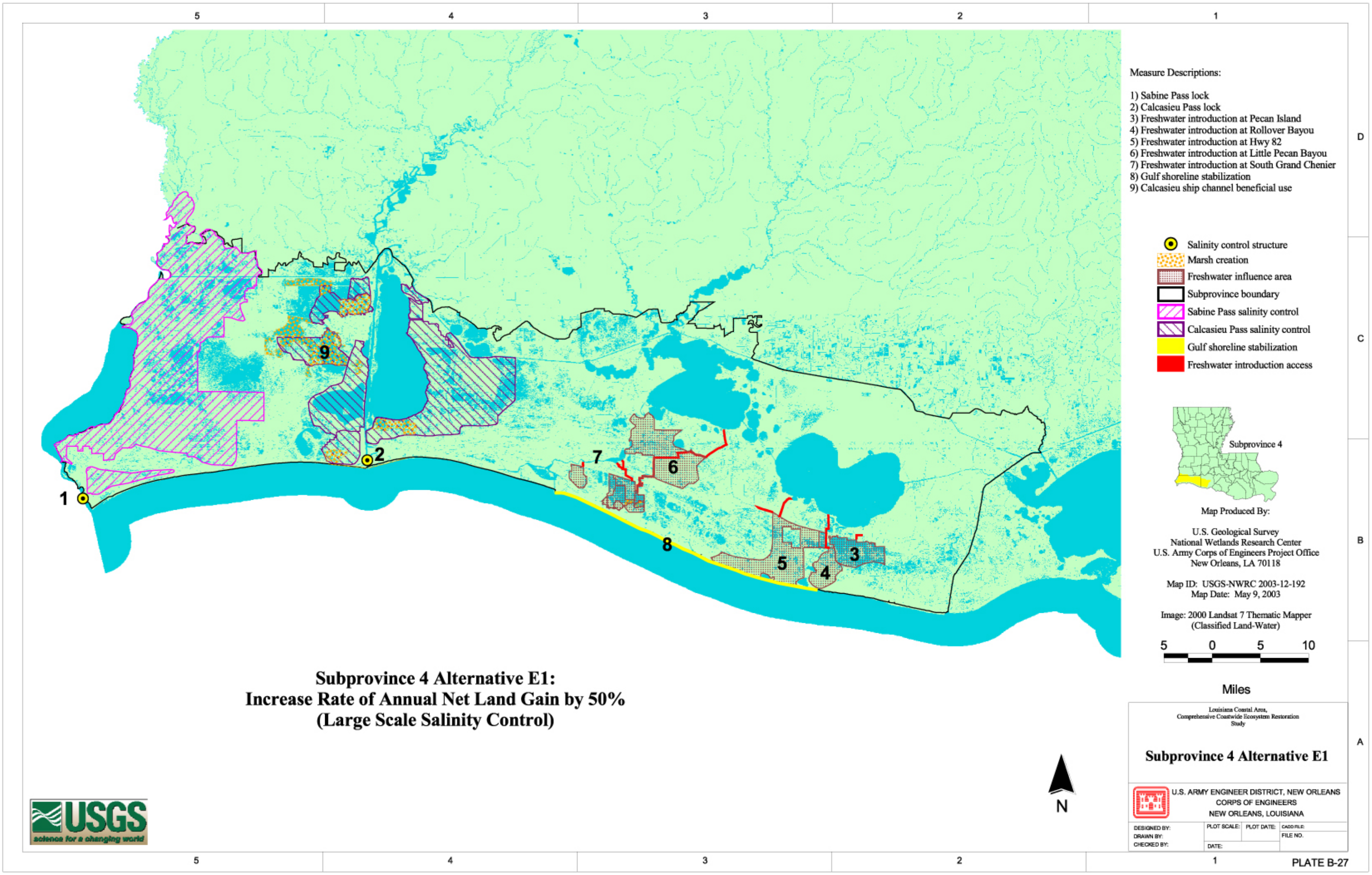
PLOT SCALE:
PLOT DATE:
DATE:
FILE NO.
PLATE B-26



Measure Descriptions:
1) Sabine Pass lock
2) Calcasieu Pass lock
3) Freshwater introduction at Pecan Island
4) Freshwater introduction at Rollover Bayou
5) Freshwater introduction at Hwy 82
6) Freshwater introduction at Little Pecan Bayou
7) Freshwater introduction at South Grand Chenier
8) Gulf shoreline stabilization
9) Calcasieu ship channel beneficial use
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine Pass salinity control
Calcasieu Pass salinity control
Gulf shoreline stabilization
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-192
Map Date: May 9, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10
Miles
Subprovince 4 Alternative E1:
Increase Rate of Annual Net Land Gain by 50%
(Large Scale Salinity Control)
N
USGS
science for a changing world
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 4 Alternative E1
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
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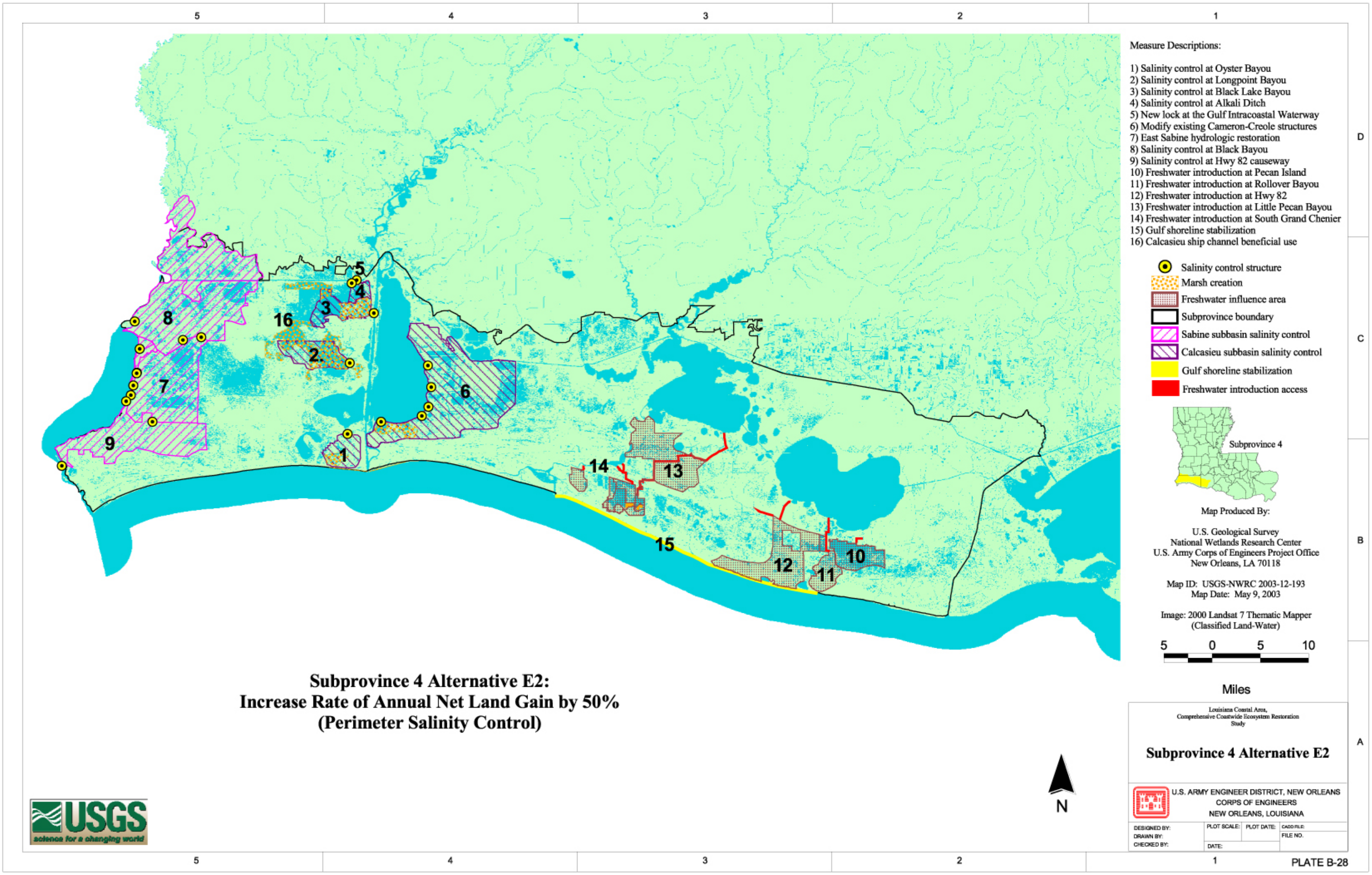
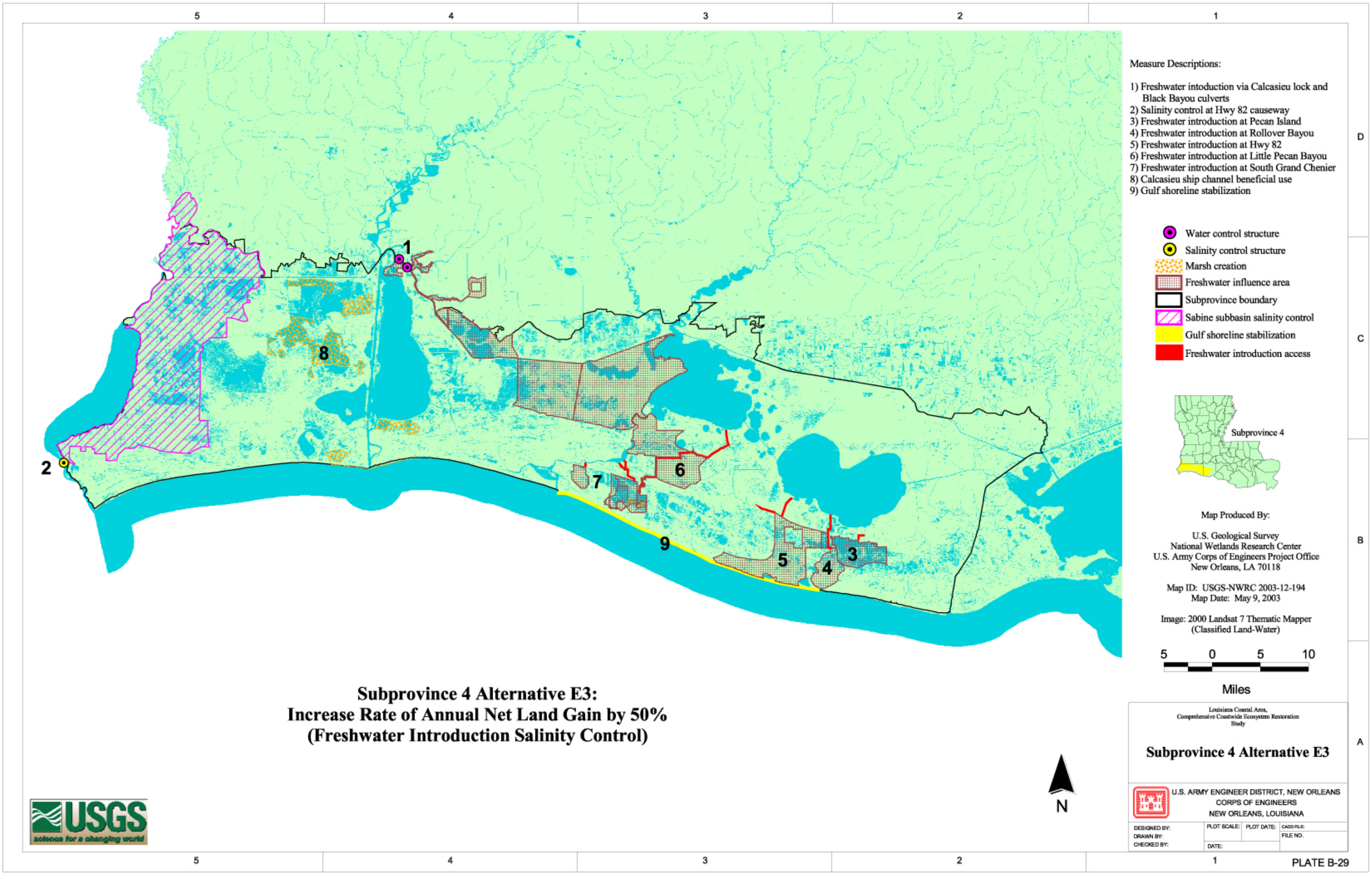
PLOT SCALE:
PLOT DATE:
CADD FILE:
FILE NO.
DATE:
PLATE B-27


Measure Descriptions:
1) Salinity control at Oyster Bayou
2) Salinity control at Longpoint Bayou
3) Salinity control at Black Lake Bayou
4) Salinity control at Alkali Ditch
5) New lock at the Gulf Intracoastal Waterway
6) Modify existing Cameron-Creole structures
7) East Sabine hydrologic restoration
8) Salinity control at Black Bayou
9) Salinity control at Hwy 82 causeway
10) Freshwater introduction at Pecan Island
11) Freshwater introduction at Rollover Bayou
12) Freshwater introduction at Hwy 82
13) Freshwater introduction at Little Pecan Bayou
14) Freshwater introduction at South Grand Chenier
15) Gulf shoreline stabilization
16) Calcasieu ship channel beneficial use
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine subbasin salinity control
Calcasieu subbasin salinity control
Gulf shoreline stabilization
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-193
Map Date: May 9, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10
Miles
Subprovince 4 Alternative E2:
Increase Rate of Annual Net Land Gain by 50%
(Perimeter Salinity Control)
N
USGS
science for a changing world
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 4 Alternative E2
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
PLATE B-28


Measure Descriptions:
1) Freshwater intoduction via Calcasieu lock and Black Bayou culverts
2) Salinity control at Hwy 82 causeway
3) Freshwater introduction at Pecan Island
4) Freshwater introduction at Rollover Bayou
5) Freshwater introduction at Hwy 82
6) Freshwater introduction at Little Pecan Bayou
7) Freshwater introduction at South Grand Chenier
8) Calcasieu ship channel beneficial use
9) Gulf shoreline stabilization
Water control structure
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine subbasin salinity control
Gulf shoreline stabilization
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-194
Map Date: May 9, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
5 0 5 10
Miles
Subprovince 4 Alternative E3:
Increase Rate of Annual Net Land Gain by 50%
(Freshwater Introduction Salinity Control)
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 4 Alternative E3
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
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PLOT SCALE:
PLOT DATE:
DATE:
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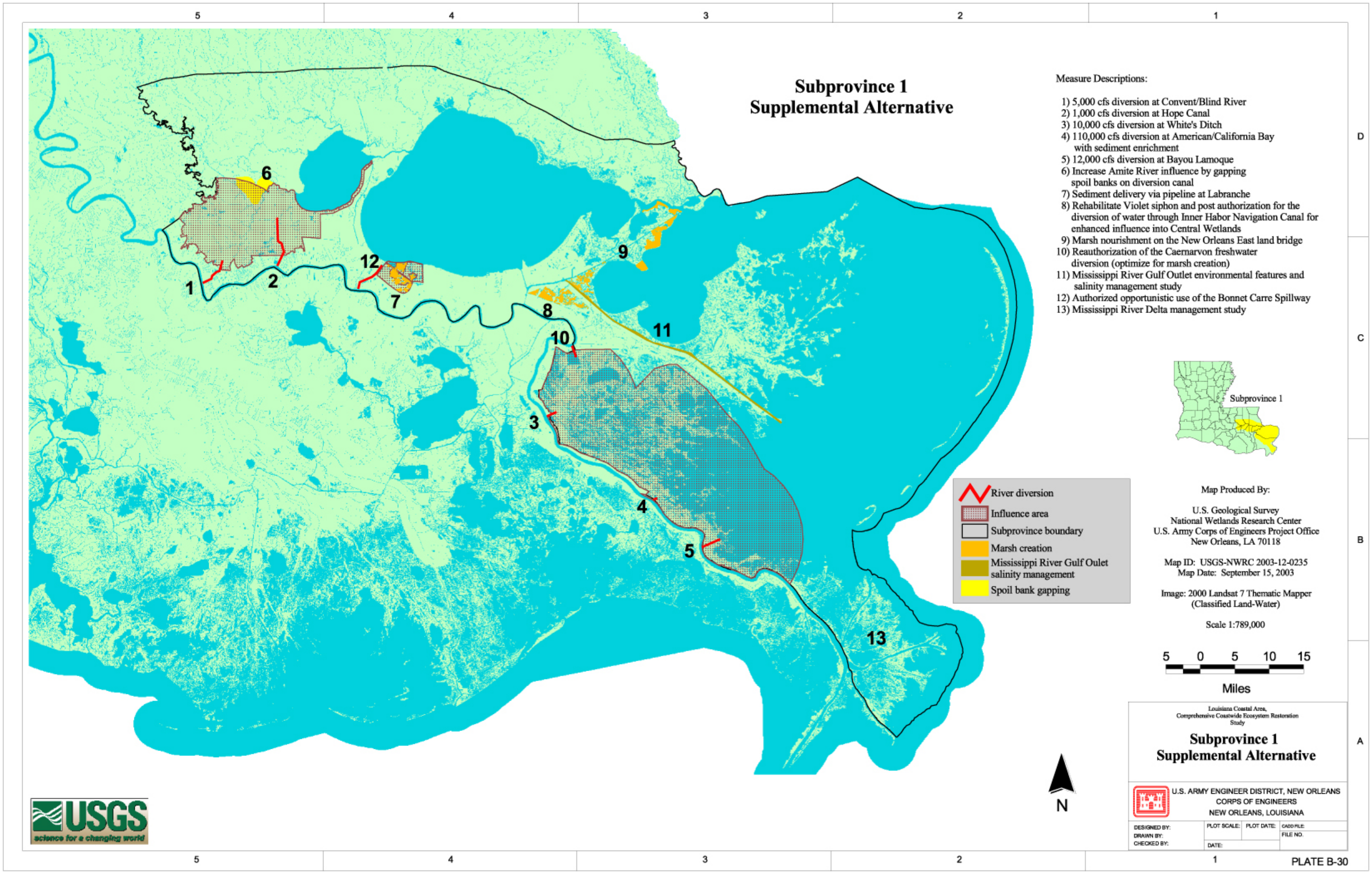
USGS
science for a changing world
PLATE B-29


Subprovince 1
Supplemental Alternative
Measure Descriptions:
1) 5,000 cfs diversion at Convent/Blind River
2) 1,000 cfs diversion at Hope Canal
3) 10,000 cfs diversion at White's Ditch
4) 110,000 cfs diversion at American/California Bay with sediment enrichment
5) 12,000 cfs diversion at Bayou Lamoque
6) Increase Amite River influence by gapping spoil banks on diversion canal
7) Sediment delivery via pipeline at Labranche
8) Rehabilitate Violet siphon and post authorization for the diversion of water through Inner Habor Navigation Canal for enhanced influence into Central Wetlands
9) Marsh nourishment on the New Orleans East land bridge
10) Reauthorization of the Caernarvon freshwater diversion (optimize for marsh creation)
11) Mississippi River Gulf Outlet environmental features and salinity management study
12) Authorized opportunistic use of the Bonnet Carre Spillway
13) Mississippi River Delta management study
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13
Subprovince 1
River diversion
Influence area
Subprovince boundary
Marsh creation
Mississippi River Gulf Oulet salinity management
Spoil bank gapping
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0235
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper (Classified Land-Water)
Scale 1:789,000
5 0 5 10 15
Miles
N
USGS
science for a changing world
Louisiana Coastal Area, Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 1
Supplemental Alternative
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
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PLOT SCALE:
PLOT DATE:
DATE:
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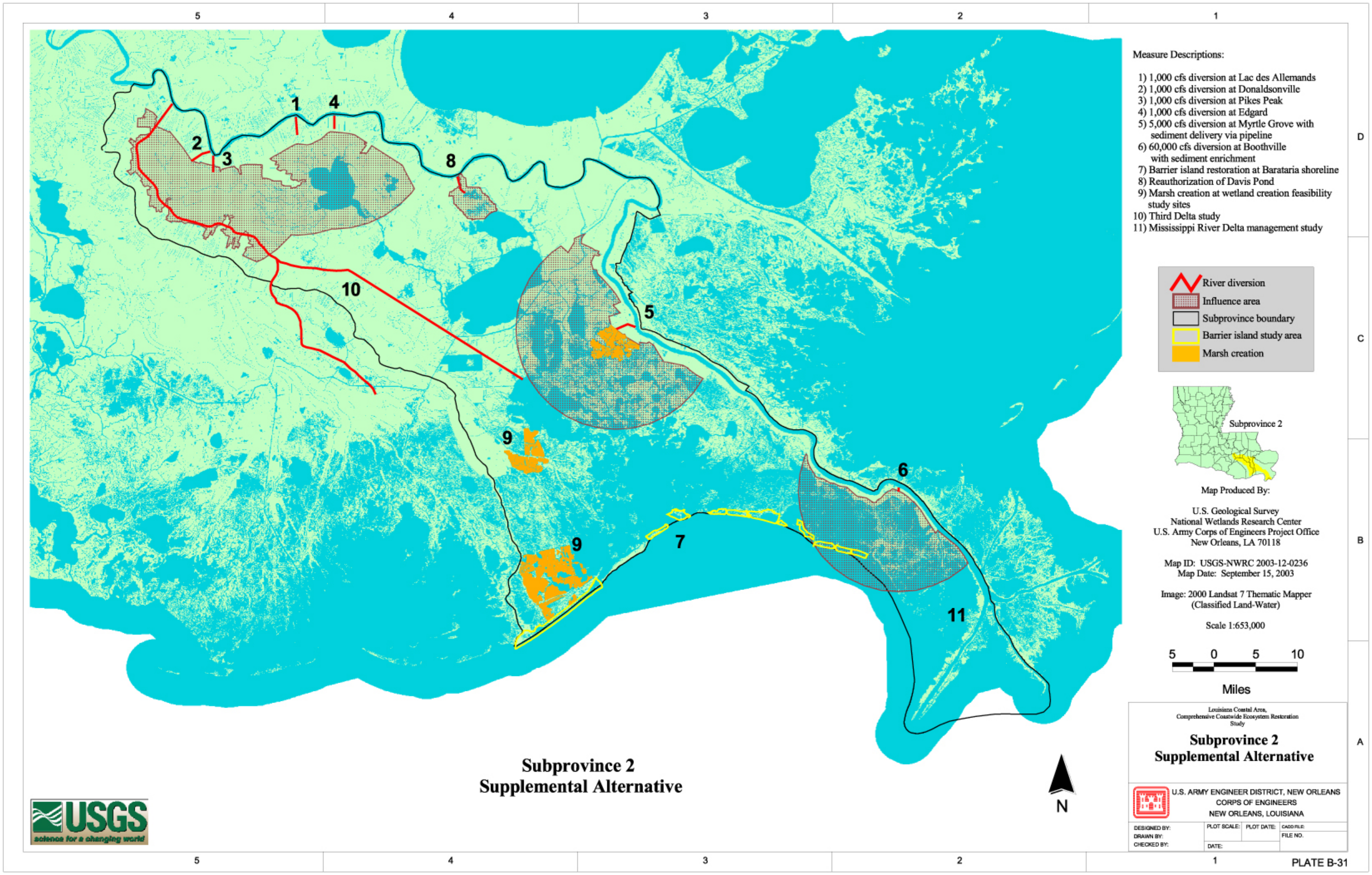
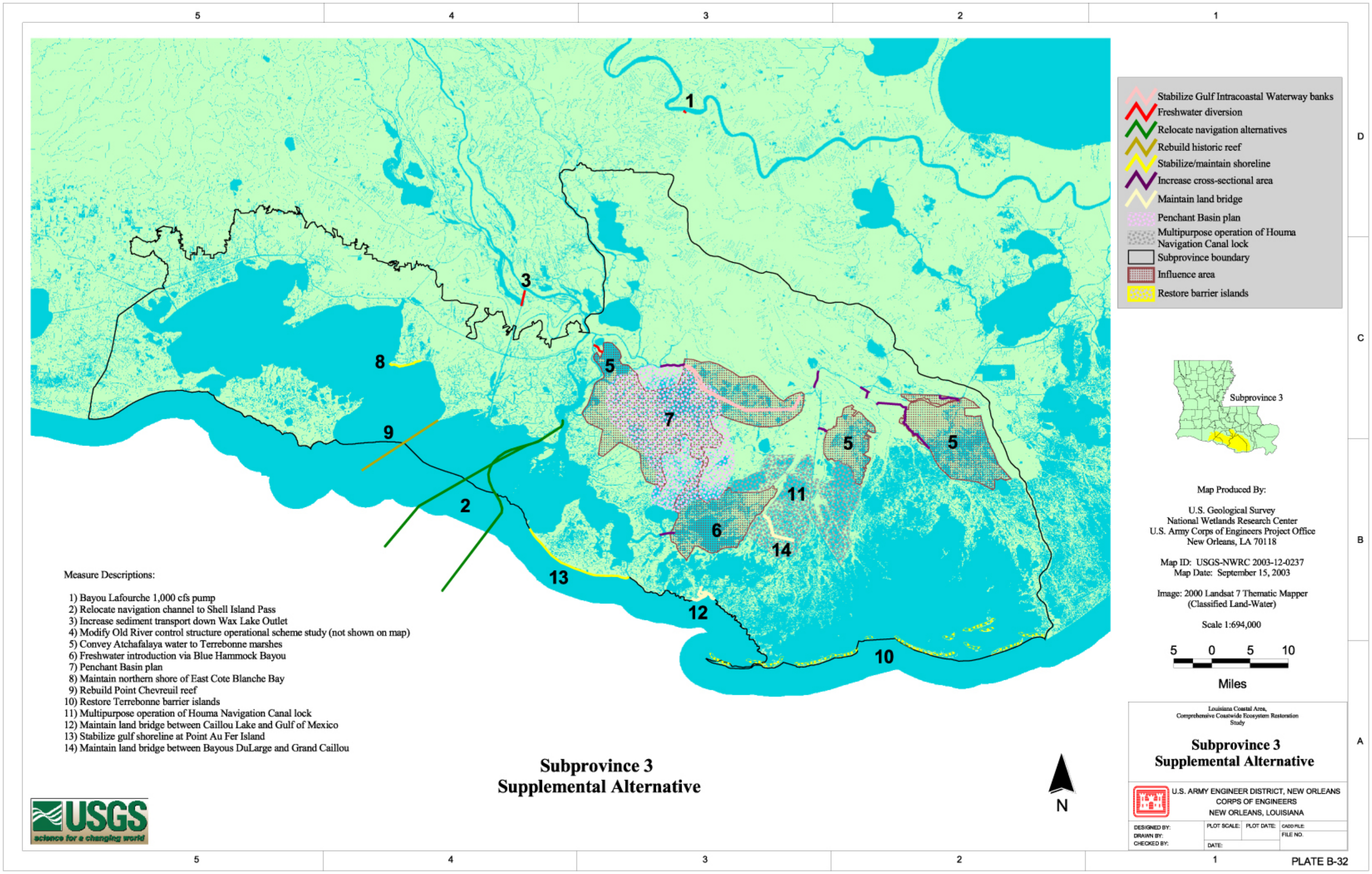
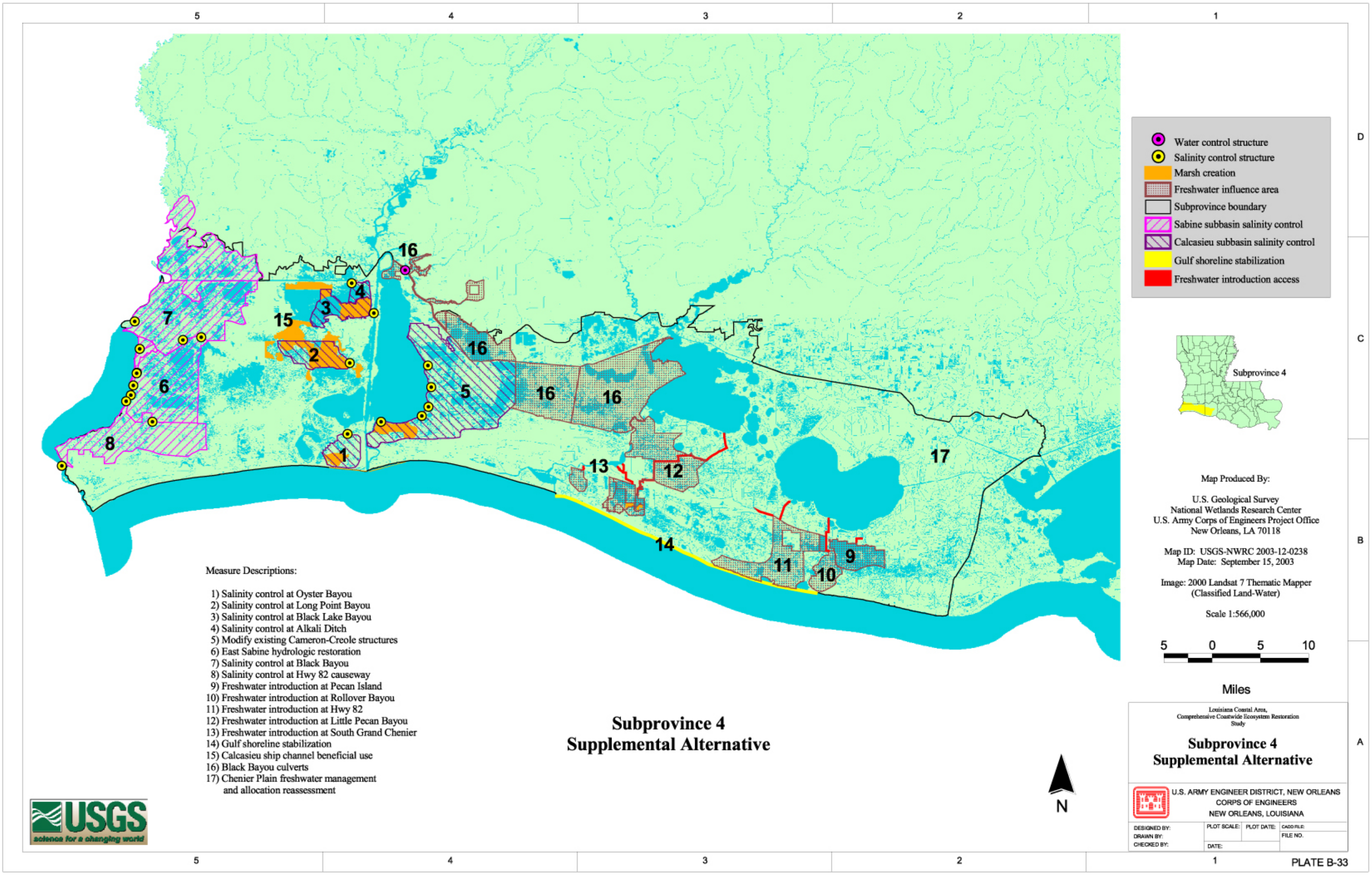
FILE NO.
PLATE B-30



Measure Descriptions:
1) 1,000 cfs diversion at Lac des Allemands
2) 1,000 cfs diversion at Donaldsonville
3) 1,000 cfs diversion at Pikes Peak
4) 1,000 cfs diversion at Edgard
5) 5,000 cfs diversion at Myrtle Grove with sediment delivery via pipeline
6) 60,000 cfs diversion at Boothville with sediment enrichment
7) Barrier island restoration at Barataria shoreline
8) Reauthorization of Davis Pond
9) Marsh creation at wetland creation feasibility study sites
10) Third Delta study
11) Mississippi River Delta management study
River diversion
Influence area
Subprovince boundary
Barrier island study area
Marsh creation
Subprovince 2
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0236
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
Scale 1:653,000
5 0 5 10
Miles
Subprovince 2
Supplemental Alternative
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
Subprovince 2
Supplemental Alternative
USGS
N
PLATE B-31


Stabilize Gulf Intracoastal Waterway banks
Freshwater diversion
Relocate navigation alternatives
Rebuild historic reef
Stabilize/maintain shoreline
Increase cross-sectional area
Maintain land bridge
Penchant Basin plan
Multipurpose operation of Houma Navigation Canal lock
Subprovince boundary
Influence area
Restore barrier islands
Subprovince 3
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0237
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
Scale 1:694,000
5 0 5 10
Miles
Measure Descriptions:
1) Bayou Lafourche 1,000 cfs pump
2) Relocate navigation channel to Shell Island Pass
3) Increase sediment transport down Wax Lake Outlet
4) Modify Old River control structure operational scheme study (not shown on map)
5) Convey Atchafalaya water to Terrebonne marshes
6) Freshwater introduction via Blue Hammock Bayou
7) Penchant Basin plan
8) Maintain northern shore of East Cote Blanche Bay
9) Rebuild Point Chevreuil reef
10) Restore Terrebonne barrier islands
11) Multipurpose operation of Houma Navigation Canal lock
12) Maintain land bridge between Caillou Lake and Gulf of Mexico
13) Stabilize gulf shoreline at Point Au Fer Island
14) Maintain land bridge between Bayous DuLarge and Grand Caillou
Subprovince 3
Supplemental Alternative
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration Study
Subprovince 3
Supplemental Alternative
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
DRAWN BY:
CHECKED BY:
PLOT SCALE:
PLOT DATE:
DATE:
FILE NO.
PLATE B-32


Water control structure
Salinity control structure
Marsh creation
Freshwater influence area
Subprovince boundary
Sabine subbasin salinity control
Calcasieu subbasin salinity control
Gulf shoreline stabilization
Freshwater introduction access
Subprovince 4
Map Produced By:
U.S. Geological Survey
National Wetlands Research Center
U.S. Army Corps of Engineers Project Office
New Orleans, LA 70118
Map ID: USGS-NWRC 2003-12-0238
Map Date: September 15, 2003
Image: 2000 Landsat 7 Thematic Mapper
(Classified Land-Water)
Scale 1:566,000
5 0 5 10
Miles
Measure Descriptions:
1) Salinity control at Oyster Bayou
2) Salinity control at Long Point Bayou
3) Salinity control at Black Lake Bayou
4) Salinity control at Alkali Ditch
5) Modify existing Cameron-Creole structures
6) East Sabine hydrologic restoration
7) Salinity control at Black Bayou
8) Salinity control at Hwy 82 causeway
9) Freshwater introduction at Pecan Island
10) Freshwater introduction at Rollover Bayou
11) Freshwater introduction at Hwy 82
12) Freshwater introduction at Little Pecan Bayou
13) Freshwater introduction at South Grand Chenier
14) Gulf shoreline stabilization
15) Calcasieu ship channel beneficial use
16) Black Bayou culverts
17) Chenier Plain freshwater management
and allocation reassessment
Subprovince 4
Supplemental Alternative
USGS
science for a changing world
N
Louisiana Coastal Area,
Comprehensive Coastwide Ecosystem Restoration
Study
Subprovince 4
Supplemental Alternative
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA
DESIGNED BY:
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DATE:
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FILE NO.
PLATE B-33